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FY95 LIMITED ENERGY STUDY FOR THE AREA "A" PACKAGE BOILER

HOLSTON ARMY AMMUNITION PLANT
KINGSPORT, TENNESSEE

U.S. ARMY CORPS OF ENGINEERS
MOBILE DISTRICT

CONTRACT NO.: DACA01-94-D-0007
DELIVERY ORDER NO.: 003

FINAL REPORT

AESE PROJECT NO.: 95046-00

3 NOVEMBER 1995

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PER: PAUL LITTLE

(352) 376-5500

AFFILIATED ENGINEERS SE, INC.

GAINSVILLE, FL.

DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
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II. Detailed Narrative

History

Holston Army Ammunition Plant (HSAAP) in Holston, Tennessee, manufactures explosives from raw materials. The facility comprises two separate areas designated Area "A" and Area "B". Each area is served by a steam plant which produces steam for production processes, equipment operation, space heating, domestic water heating, steam tracing, and product storage heating requirements.

Construction of the steam plant serving Area "A" (Building 8-A) was completed in 1943. The majority of the equipment in the plant is the original design with relatively minor changes since the original installation. Seven boilers, each having a full-load capacity of at least 100,000 pounds per hour (lb/hr), are located in the building. Six of the boilers are coal-fired spreader stoker dump grate type. The seventh boiler is a pulverized coal-fired type. The pulverized coal fired boiler and one of the stoker type boilers are currently layed away (not operational). Only two of the five remaining stoker type boilers are currently operated, with one active and the other on stand-by. Operation is rotated on a weekly schedule.

Problem Statement

Demand for explosives has declined in the last few years and is expected to continue to decline in the near future. As production levels drop and production lines are taken out of service, the demand for steam in Area "A" has fallen.

Present steam demand averages 35 to 40,000 lb/hr. The one active boiler cannot be reduced in capacity below 35 to 40,000 lb/hr without experiencing problems with excessive smoke production. Electrostatic precipitators installed to meet federal emission standards operate effectively when the boilers are operating at more than 40,000 lb/hr, but are unable to handle the excessive smoke generated when operating below 40,000 lb/hr. The resultant smoke stack discharges exceed levels allowed by the present air pollution operating permit. When steam demand falls below the minimum operating point of one boiler, excess steam is vented to the atmosphere. This practice results in increased operating and maintenance costs to replace the mass of water (steam) lost from the system.

Purpose of the Study

The purpose of this study is to identify and evaluate the technical and economic feasibility of alternative methods of meeting the steam requirements of the Area "A" industrial complex.

The following items were specifically requested to be evaluated.

- Evaluate the use of two new gas-fired packaged boilers sized to meet the requirements of the industrial complex. The new boilers would be installed adjacent to the existing steam plant and would utilize the existing smokestacks and steam distribution system.

- Evaluate using the existing steam distribution system rather than locating multiple boilers at various sites.

- Existing steam driven chillers will be replaced with electric driven equipment. Evaluate this impact on the steam system requirements.

- Field survey and test two existing gas-fired packaged boilers located at the Volunteer Army Ammunition Plant in Chattanooga, Tennessee. The two boilers were last used about 1980 and are presently laid away. The boilers are approximately the same capacity and operating characteristics as the ones at HSAAP. Relocation of the existing boilers and ancillary equipment (feedwater pumps, deaerators, fans, etc.) would be required as well as repairs or modifications necessary to meet current operating conditions and standards. The packaged boilers would be installed adjacent to the existing steam plant and would utilize the existing smokestacks and steam distribution system.

- Include maintenance and operating costs as well as savings in evaluations. This should include lay away costs of existing equipment.

- Present natural gas service to Area "A" is billed at an uninterruptible rate and is not likely to change. Evaluate dual fuel (No. 2 fuel oil) capability of packaged boiler installations including present storage and costs of additional storage.

- Evaluate impact of any proposed installations on the current air pollution operating permit.

- Evaluate turbine drives on equipment such as riverwater pumps which are currently using electric drives. (It was noted during investigations for this project that turbines are being used in an attempt to maintain boiler demand above 4,000 lbs/hr).

Alternate methods of meeting Area "A" steam requirements which were identified and which were not evaluated as part of this study are as follows:

- Replace the existing spreader stoker dump grate equipment on one or more boilers to a more efficient continuous ash discharge stoker. This would retain the capability of burning coal but utilize a more efficient stoker. Operating and maintenance costs should be reduced.

- Replace the existing spreader stoker dump grate equipment on one or more boilers with gas fired burners. This should reduce operating and maintenance costs at the expense of losing the capability of burning coal.

The two alternatives identified above are presented as possible future studies. Retrofiting boilers of this vintage requires a detailed study of the boilers which is beyond the scope of the present study.

Study Approach

Technical and economic evaluation of alternative methods for efficiently providing steam to the anhydride production processes at Area A are based on comparisons to baseline information developed from documents representing various historical production and consumption data. Data to represent uniform annual production rates down to the projected 2 million lbs of explosive in 1996 (0.167 million lbs per month) and for the mobilization rate of 27 million lbs per month are extrapolated from the historical data.

The following assumptions have been made:

1) System piping losses (heat loss and steam leakage) are constant.

2) Oxygen content of coal fired boiler flue gas varies uniformly from 6 percent by weight at 100,000 lbs/hr steam output to 12 percent by weight at 40,000 lbs/hr steam output.

3) Natural gas burners operate at 7.5 percent excess air throughout a turndown ratio of 4:1; burners cycle off/on at boiler output below 25 percent of full load.

4) Electrical consumption of steam plant equipment for baseline conditions is 2.8 kWh/K# steam.

5) Fixed maintenance cost is $37,500 per month for coal fired operation and $18,750 per month for relocated natural gas fired boiler operation; variable maintenance cost for coal fired operation (including coal handling, ash disposal and miscellaneous consumables) is $.50 per thousand pounds steam and $.15 per thousand pounds of steam for natural gas fired boilers. Fixed maintenance cost for system operation with the new 30,000 #/hr boiler will be significantly reduced and is assumed to be between one third and one fifth of costs used for relocated boilers.

6) Fixed plant overhead cost is $70,000 per month; with Building 8A functionally viable; variable overhead cost is $0.25 per thousand pounds of steam. With Building 8A "layed away" and steam supplied by the new 30,000 #/hr boiler, fixed plant overhead is assumed to be between $35,000 and $50,000 per year.

7) Unburned fuel losses are zero under all operating conditions.

8) Coal fired boiler minimum load of 40000 #/hr is maintained artificially by venting steam from the 100 psig steam header.

9) Mollier diagram back pressure turbine steam state lines with saturated throttle steam are parallel to design process lines in the superheat region as indicated in Figure 1 and Figure 2 on the following pages.

Figure 1 - Boiler Feed Pumps

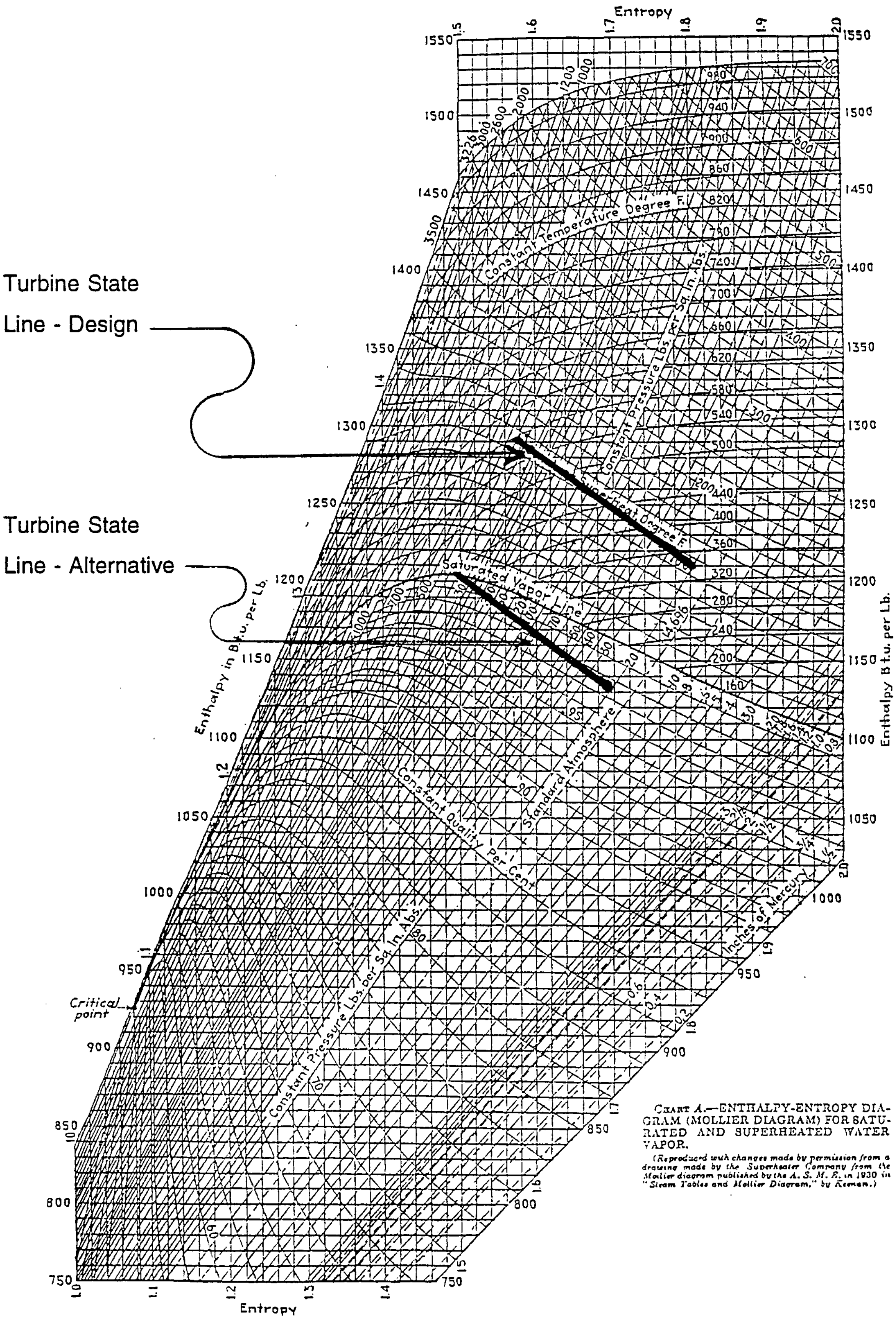
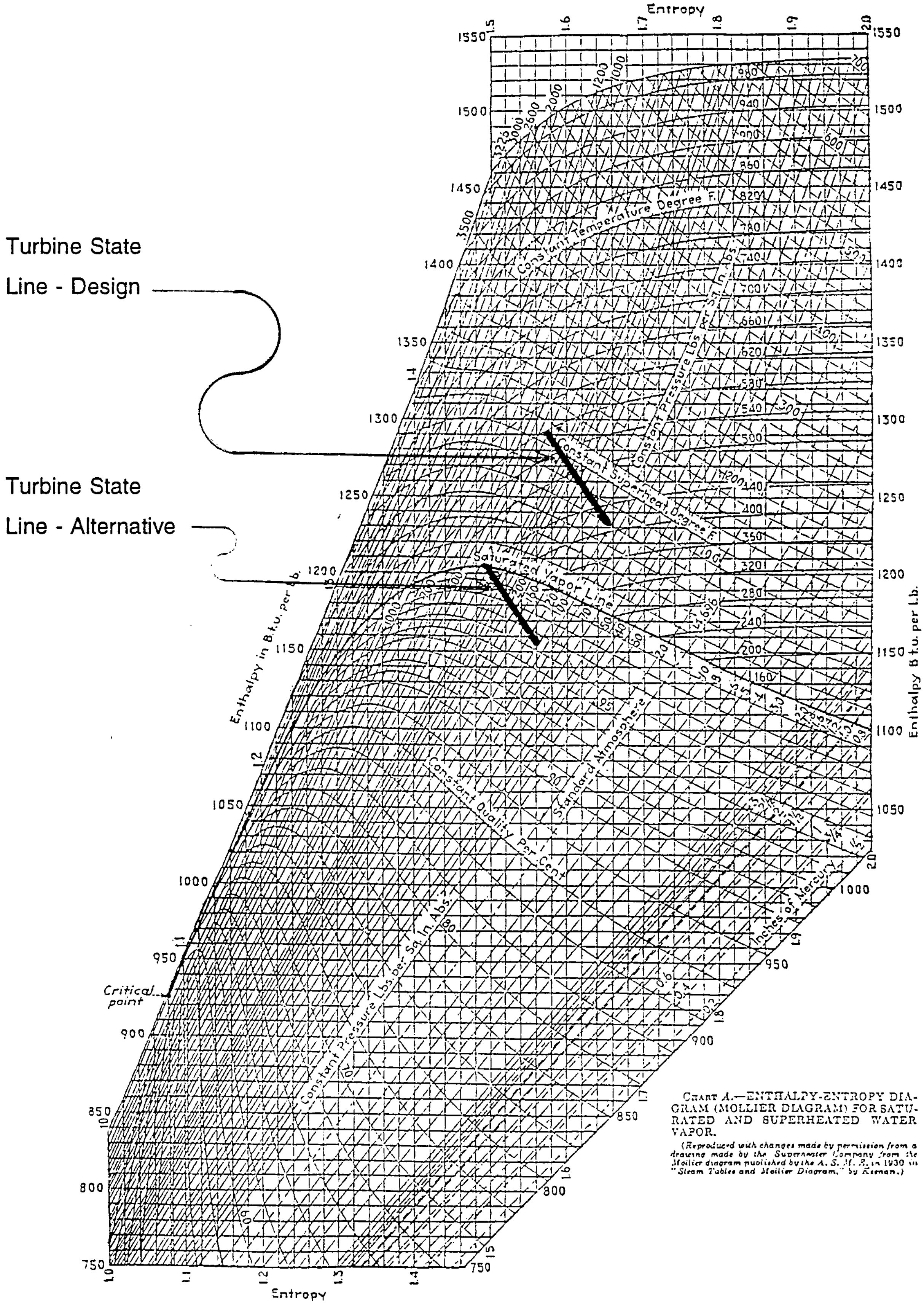


Figure 2 - River Water Pumps



10) Reduced production rates of equivalent RDX explosives will be accommodated by continuous process operation, rather than limited duration batch operations at a higher rate and with systems idle for appropriate durations.

Energy Consumption Calculations

Historical data provided by Holston Defense Corporation (HDC), including Area A Monthly Report Steam Production Data for calendar years 1989 through 1994 and partial 1995 information, and reports for fiscal years 1991, 1992, partial 1993, 1994 and partial 1995 for equivalent RDX explosives production, were used as input for computerized spreadsheet preparation. The data was then reduced to unit rating parameters pursuant to development of production curves of steam rate (lbs stm per lb equivalent RDX) versus uniform monthly production rate of explosives.

Curves for boiler efficiency versus boiler steam output were developed from abbreviated ASME combustion and boiler heat balance calculations, utilizing representative parameters from coal analysis reports for fuel delivered in February, March, May and October 1994, and January 1995, and for natural gas having heating value of 1,000 Btu/cf as indicated on United Cities Gas Company utility bill.

Conversion value used for all electrical energy calculations was 3,413 Btu/kWh.

Process steam flow rates at 400 psig, 575°F conditions were converted to equivalent flow rates for 350 psig saturated steam using steam enthalpy ratio as the conversion factor.

Completed calculation sheets and data provided by HDC are presented in Appendix 1.

Graphical representation of historical data and results of calculations are presented in Figure 3 through Figure 7 on the following pages.

Production rates below 167 thousand pounds per month have not been evaluated. This rate represents the projected production level of 2 million pounds in 1996, which is the production level included in meeting notes of the entry interview of June 2, 1995.

Figure 3 - Facility Production Rates Historical Data

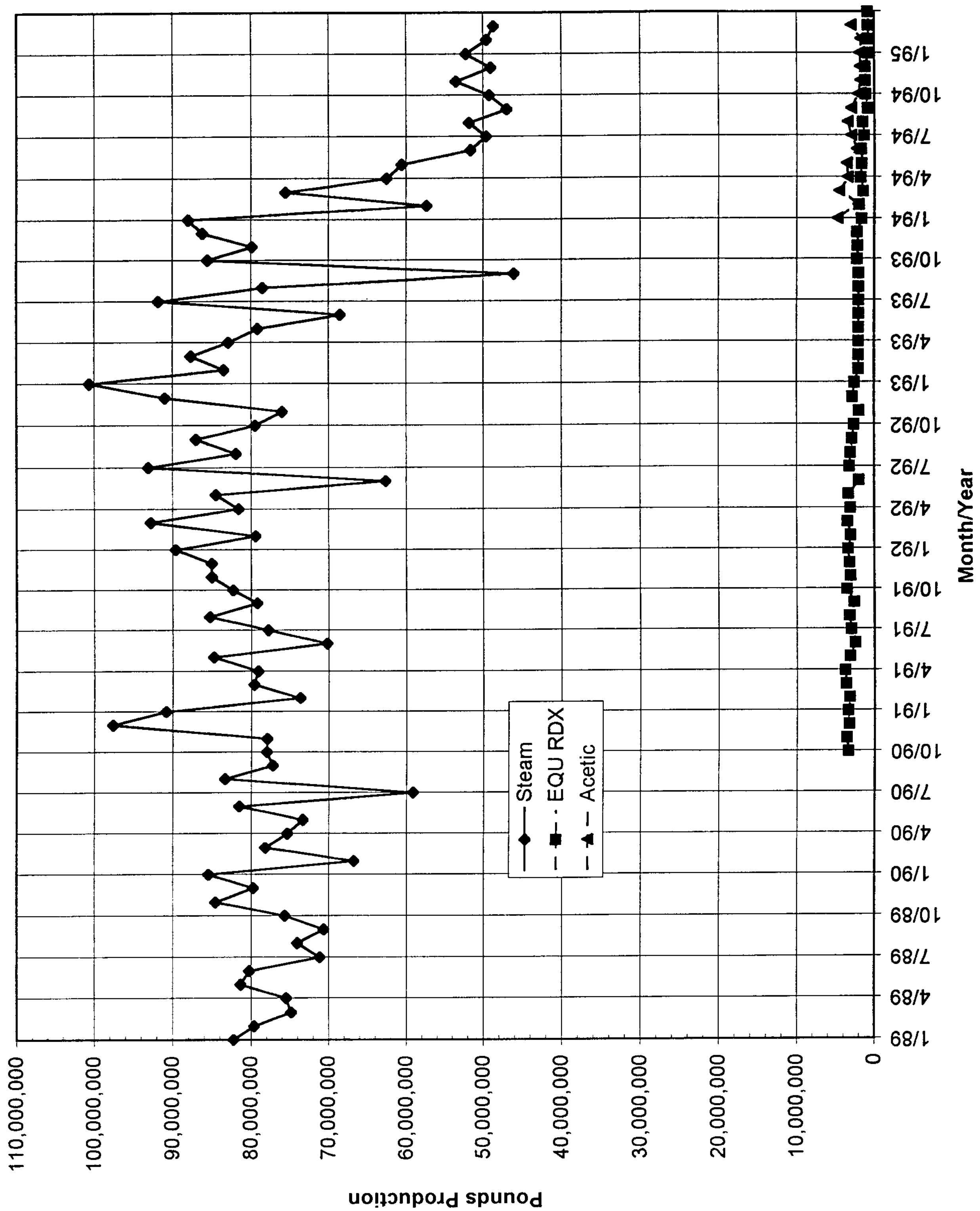


Figure 4 - Equivalent RDX Production Historical Data

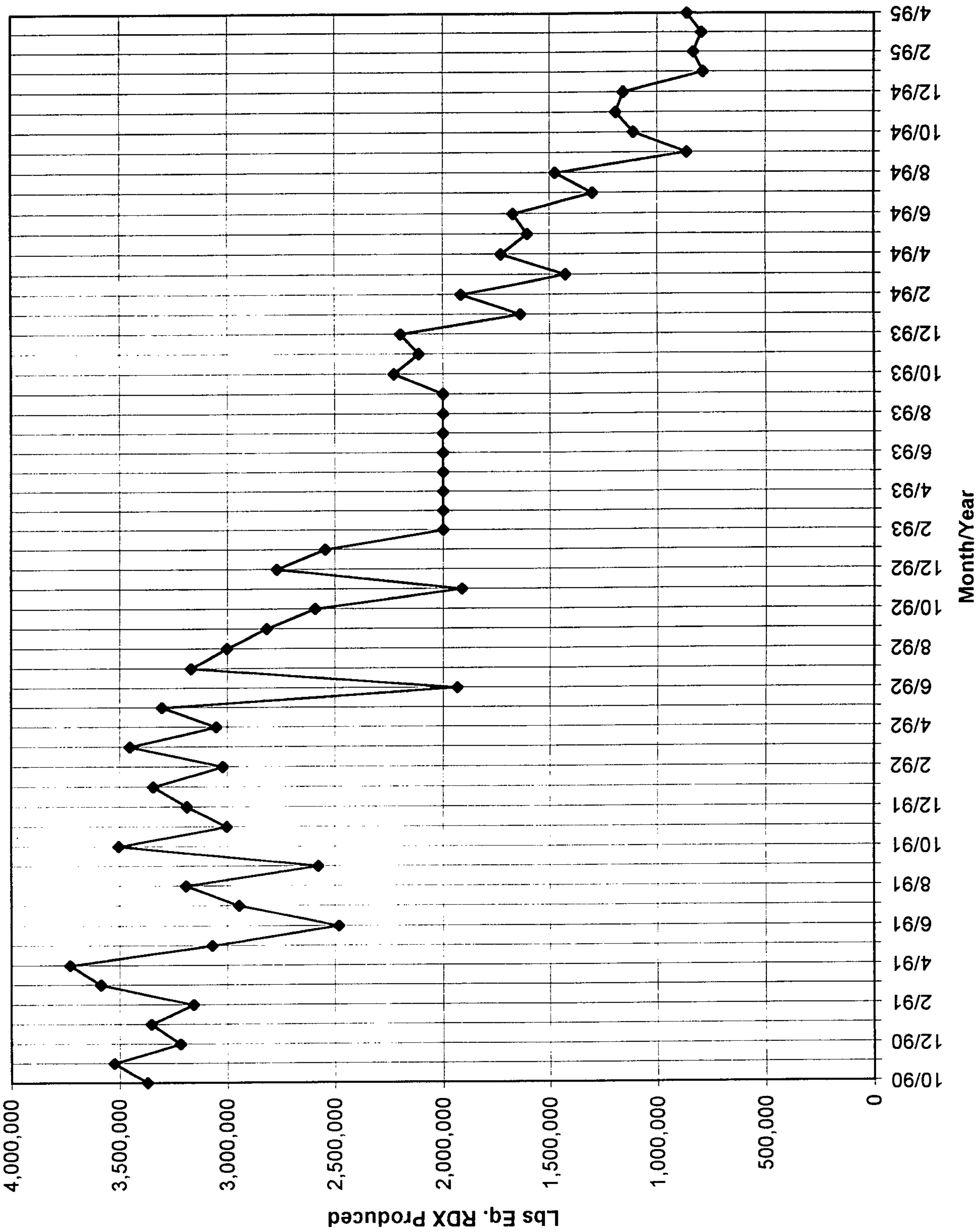


Figure 5 - Steam Production Historical Data

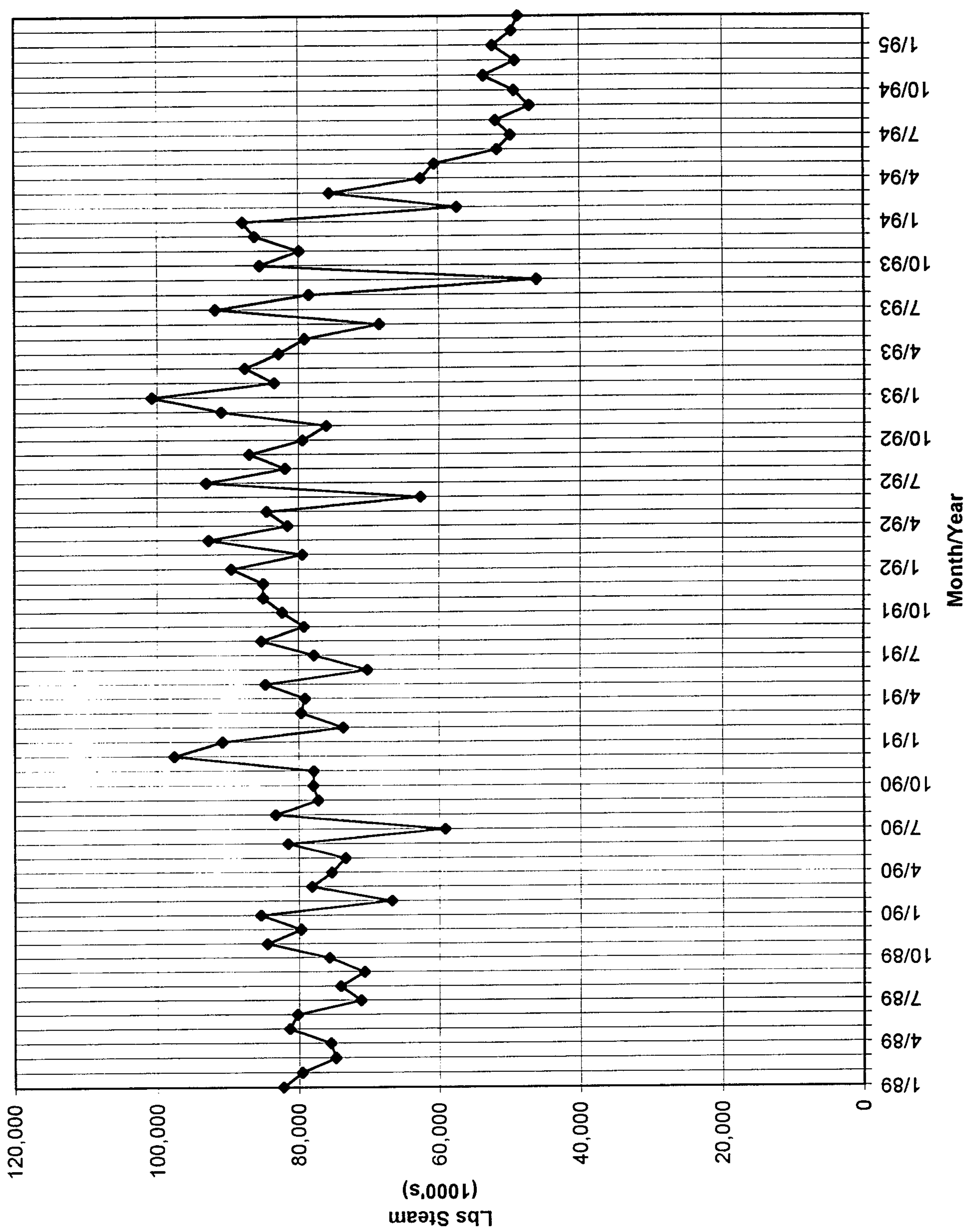


Figure 6 - Steam versus Eq. RDX Production

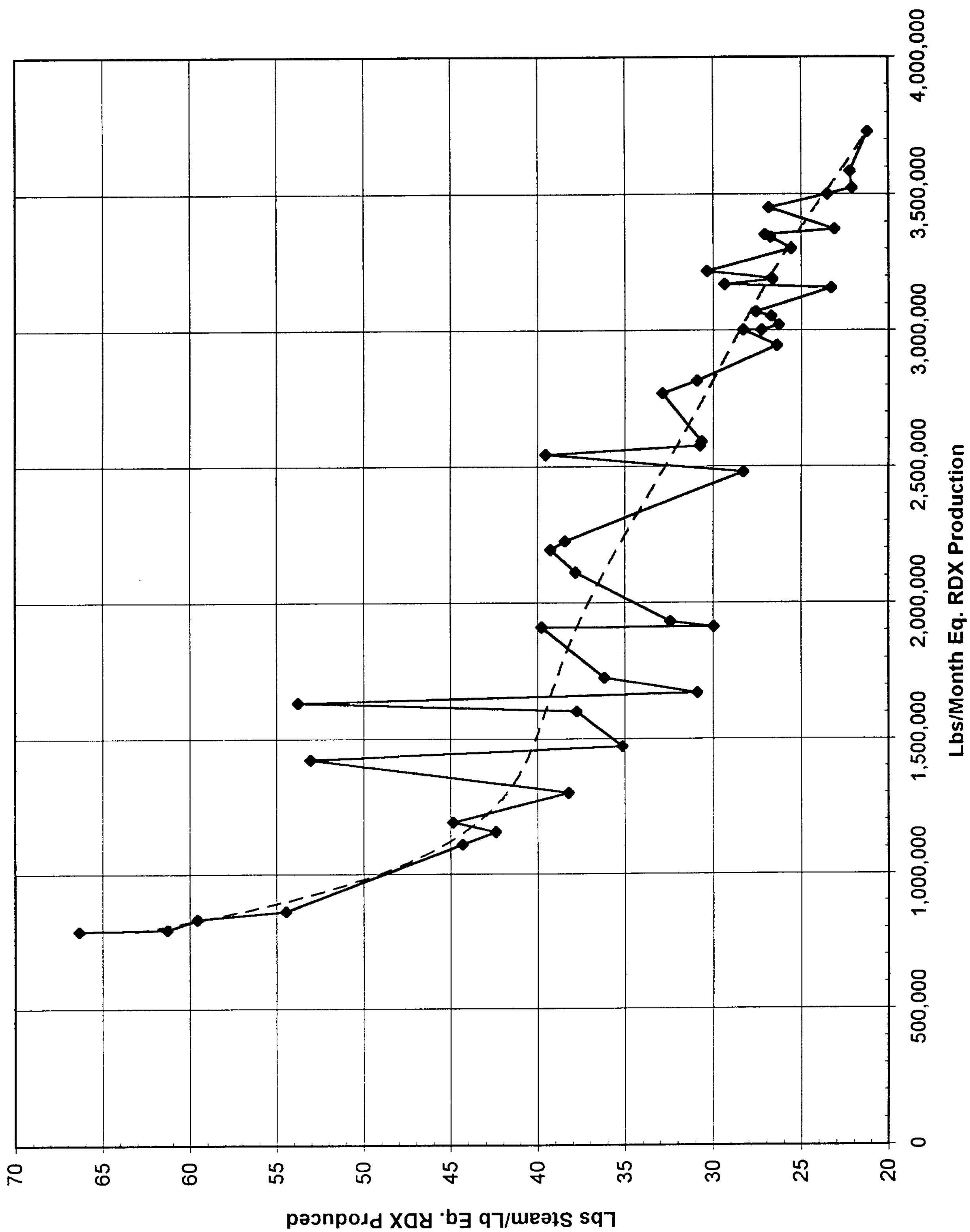
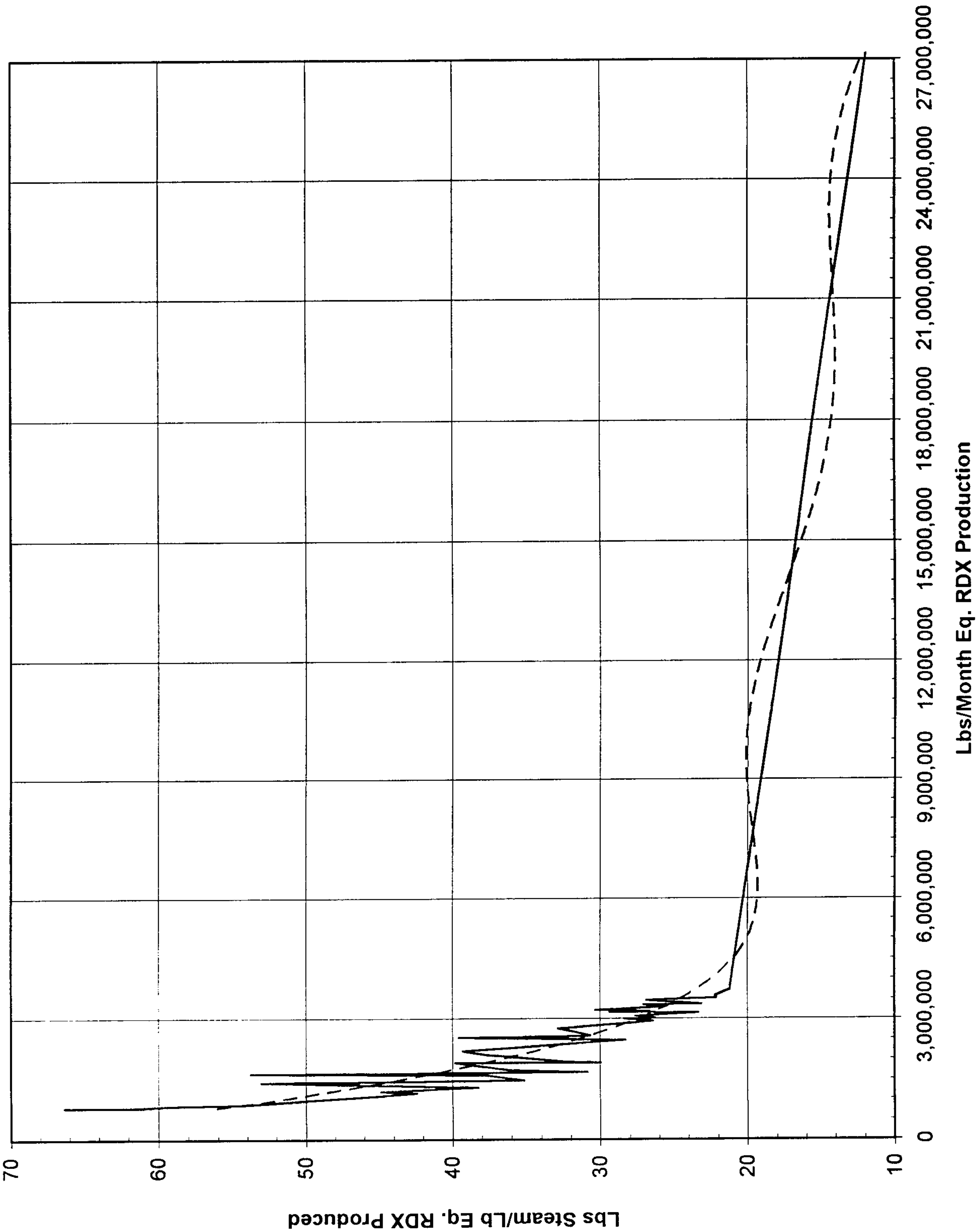


Figure 7 - Steam versus Eq. RDX Production with MOB Production Projection



Alternative Energy and Cost Savings

Baseline system energy and operating cost results (Case 1) were compared to seven alternative operating scenarios (Case 2 through Case 8). Delineated system operating mode for each case, and results of each analysis, are as follows:

Case 1 baseline scenario represents operation using coal fired, stoker operated steam boilers with boiler feedwater pumps, river water pumps and ID/FD fans driven by the existing non-condensing back pressure steam turbines.

For eight discrete equivalent RDX production rates between 0.15 million pounds per month, steam requirements and associated costs were calculated using the Microsoft Excel spreadsheet program. Keyboard input included unit cost of fuel, steam enthalpy, steam rate per unit of production (from Figures 6 and 7), and boiler efficiency (from modified ASME combustion and heat balance calculations). Formulae for calculated values in other spreadsheet columns are presented in Appendix 1.

Table 1 and Figure 8 on the following pages show baseline conditions of Case 1. Corresponding tabular and graphical representation for comparative cases (ECO's), as well as applicable Life Cycle Cost Analysis Summary sheets, are presented following each case description.

Case 2 scenario represents operation of baseline coal fired steam production, with boiler feedwater pumps and river water pumps electric driven, and ID/FD fans turbine driven.

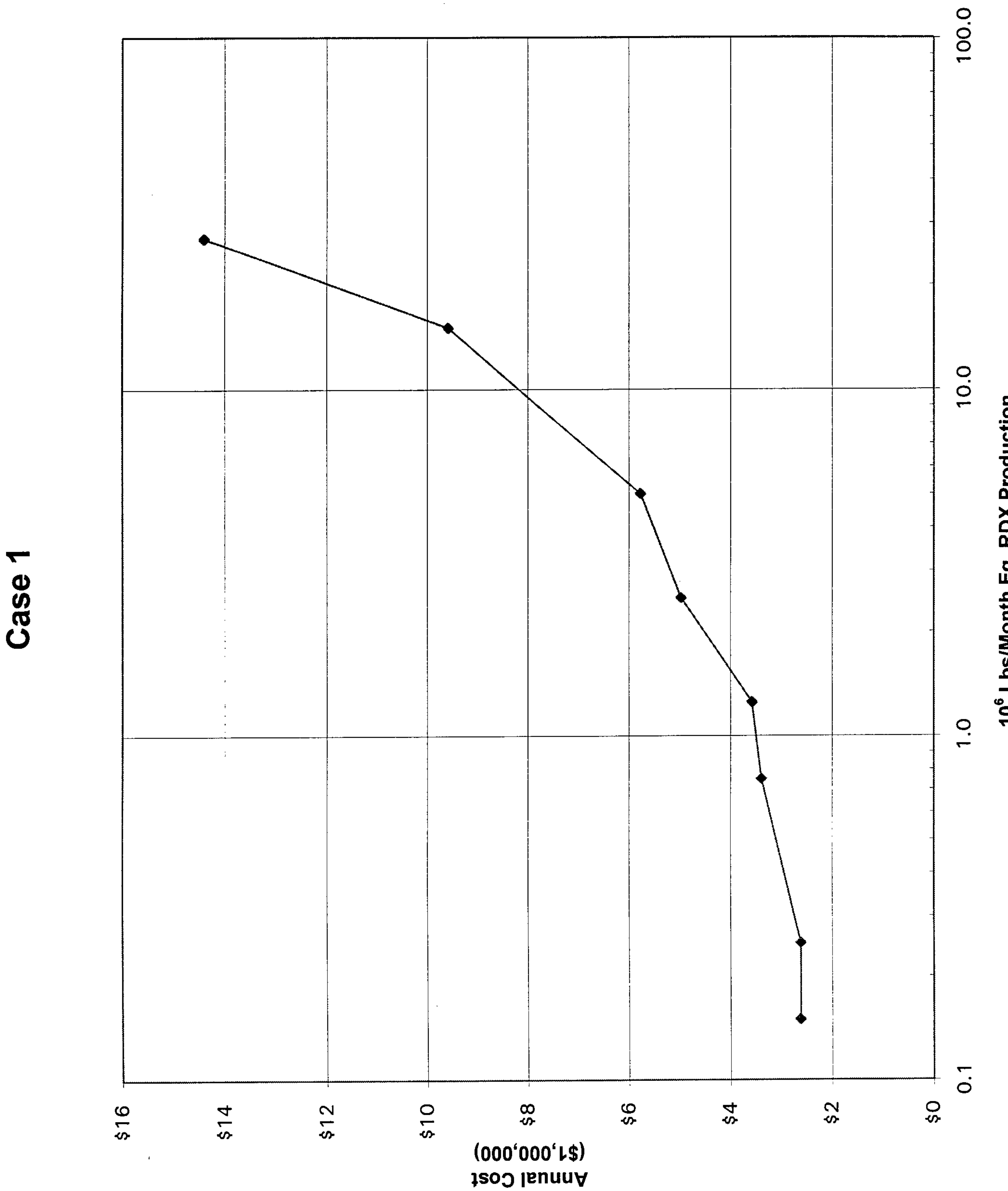
Appropriate input parameters were changed in the Excel spreadsheet, resulting in new annual cost values. These results are shown in Table 2 and Figure 9 herein. LCCID analysis summary for Case 2 follows on page 23.

Case 3 is similar to Case 2, with one of the existing boilers retrofitted with a natural gas burner installed in the existing abandoned tar burner opening to enable steam production rates below 40,000 #/hr without exceeding regulated emission rates. Results of changing the appropriate input parameters are shown in Table 3 and Figure 10 herein. LCCID analysis summary for Case 3 follows on page 28.

Table 1

CASE NO. 1: EXSTG. SYST - RIV. WTR. & BLR. FD. PMPS. & ID/FD FANS TURB. DRVN.						
MILL. #/MO. EQUIV. RDX	$/MILL. BTU	STEAM BTU/#	# STEAM PER #RDX	STEAM TURB-INE #/HR	STEAM AVG.#/HR	BOILER EFFIC.
0.15	1.86	1290.20	110.00	38759.32	40000.00	75.00
0.25	1.86	1290.20	85.00	39697.60	40000.00	75.00
0.75	1.86	1290.20	65.00	45129.79	66780.82	80.70
1.25	1.86	1290.20	42.00	45870.55	71917.81	79.50
2.50	1.86	1290.20	33.00	68093.15	113013.70	77.20
5.00	1.86	1290.20	20.50	75994.52	140410.96	79.20
15.00	1.86	1290.20	13.00	151057.53	267123.29	82.10
27.00	1.86	1290.20	11.50	280837.53	425342.47	82.90
MILL. #/MO. EQUIV. RDX	FUEL MILL. BTU/MO	ANNUAL FUEL COST	ANNUAL ELECT. COST	ANNUAL; MNTNC. COST	ANNUAL OVRHD. COST	TOTAL ANNUAL COST
0.15	46,338	$1,034,274.28	$34,339.20	$625,200.00	$927,600.00	$2,621,413.48
0.25	46,338	$1,034,274.28	$34,339.20	$625,200.00	$927,600.00	$2,621,413.48
0.75	71,899	$1,604,778.96	$57,330.00	$742,500.00	$986,250.00	$3,390,858.96
1.25	78,598	$1,754,309.89	$61,740.00	$765,000.00	$997,500.00	$3,578,549.89
2.50	127,191	$2,838,904.51	$97,020.00	$945,000.00	$1,087,500.00	$4,968,424.51
5.00	154,035	$3,438,055.00	$120,540.00	$1,065,000.00	$1,147,500.00	$5,771,095.00
15.00	282,691	$6,309,654.67	$229,320.00	$1,620,000.00	$1,425,000.00	$9,583,974.67
27.00	445,787	$9,949,957.14	$365,148.00	$2,313,000.00	$1,771,500.00	$14,399,605.14

Figure 8



Case 1
$16
$14
$12
$10
$8
$6
$4
$2
$0
Annual Cost
($1,000,000)
0.1
1.0
10.0
100.0
10^6 Lbs/Month Eq. RDX Production

Life Cycle Analysis Summary

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: 95046
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.080
INSTALLATION & LOCATION: HOLSTON AAP REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: 95046-00 LIMITED ENERGY STUDY
FISCAL YEAR 1996 DISCRETE PORTION NAME: CASE 2: ELECT. VS. TURB. PMPS.
ANALYSIS DATE: 10-26-95 ECONOMIC LIFE 15 YEARS PREPARED BY: P. D. LITTLE

1. INVESTMENT

A. CONSTRUCTION COST	$	0.
B. SIOH	$	0.
C. DESIGN COST	$	0.
D. TOTAL COST (1A+1B+1C)	$	0.
E. SALVAGE VALUE OF EXISTING EQUIPMENT	$	0.
F. PUBLIC UTILITY COMPANY REBATE	$	0.
G. TOTAL INVESTMENT (1D - 1E - 1F)	$	0.

****** No investment costs; Other items should be checked. ******

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 10.25	-25495.	$ -261324.	12.43	$ -3248254.
B. DIST	$ .00	0.	$ 0.	13.56	$ 0.
C. RESID	$ .00	0.	$ 0.	15.09	$ 0.
D. NAT G	$ 3.95	0.	$ 0.	15.86	$ 0.
E. COAL	$ 1.86	0.	$ 0.	13.61	$ 0.
F. LPG	$ .00	0.	$ 0.	12.64	$ 0.
M. DEMAND SAVINGS			$ 0.	11.85	$ 0.
N. TOTAL		-25495.	$ -261324.		$ -3248254.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.85
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ -261324.

5. SIMPLE PAYBACK PERIOD (1G/4) .00 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ -3248254.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= ******
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 931.00 %

Table 2

CASE NO. 2: EXSTG. SYST. - PUMPS ELECTRIC DRIVEN; ID/FD FANS TURB. DRVN.						
MILL. #/MO. EQUIV. RDX	$/MILL. BTU	STEAM BTU/#	# STEAM PER #RDX	STEAM TURB-INE #/HR	STEAM AVG.#/HR	BOILER EFFIC.
0.15	1.86	1290.20	110.00	1629.66	40000.00	75.00
0.25	1.86	1290.20	85.00	2098.80	40000.00	75.00
0.75	1.86	1290.20	65.00	4814.90	66780.82	77.50
1.25	1.86	1290.20	42.00	5185.27	71917.81	78.10
2.50	1.86	1290.20	33.00	16296.58	113013.70	83.20
5.00	1.86	1290.20	20.50	20247.26	140410.96	78.20
15.00	1.86	1290.20	13.00	57778.77	267123.29	81.00
27.00	1.86	1290.20	11.50	122668.77	425342.47	83.20
MILL. #/MO. EQUIV. RDX	FUEL MILL. BTU/MO	ANNUAL FUEL COST	ANNUAL ELECT. COST	ANNUAL; MNTNC. COST	ANNUAL OVRHD. COST	TOTAL ANNUAL COST
0.15	46,338	$1,034,274.28	$295,783.15	$625,200.00	$927,600.00	$2,882,857.43
0.25	46,338	$1,034,274.28	$295,783.15	$625,200.00	$927,600.00	$2,882,857.43
0.75	74,867	$1,671,040.80	$340,270.35	$742,500.00	$986,250.00	$3,740,061.15
1.25	80,007	$1,785,757.18	$348,803.70	$765,000.00	$997,500.00	$3,897,060.88
2.50	118,019	$2,634,175.82	$507,784.20	$945,000.00	$1,087,500.00	$5,174,460.02
5.00	156,004	$3,482,019.90	$804,623.40	$1,065,000.00	$1,147,500.00	$6,499,143.30
15.00	286,530	$6,395,341.33	$1,560,573.00	$1,620,000.00	$1,425,000.00	$11,000,914.33
27.00	444,179	$9,914,079.89	$2,418,811.92	$2,313,000.00	$1,771,500.00	$16,417,391.81

Figure 9

Case 2

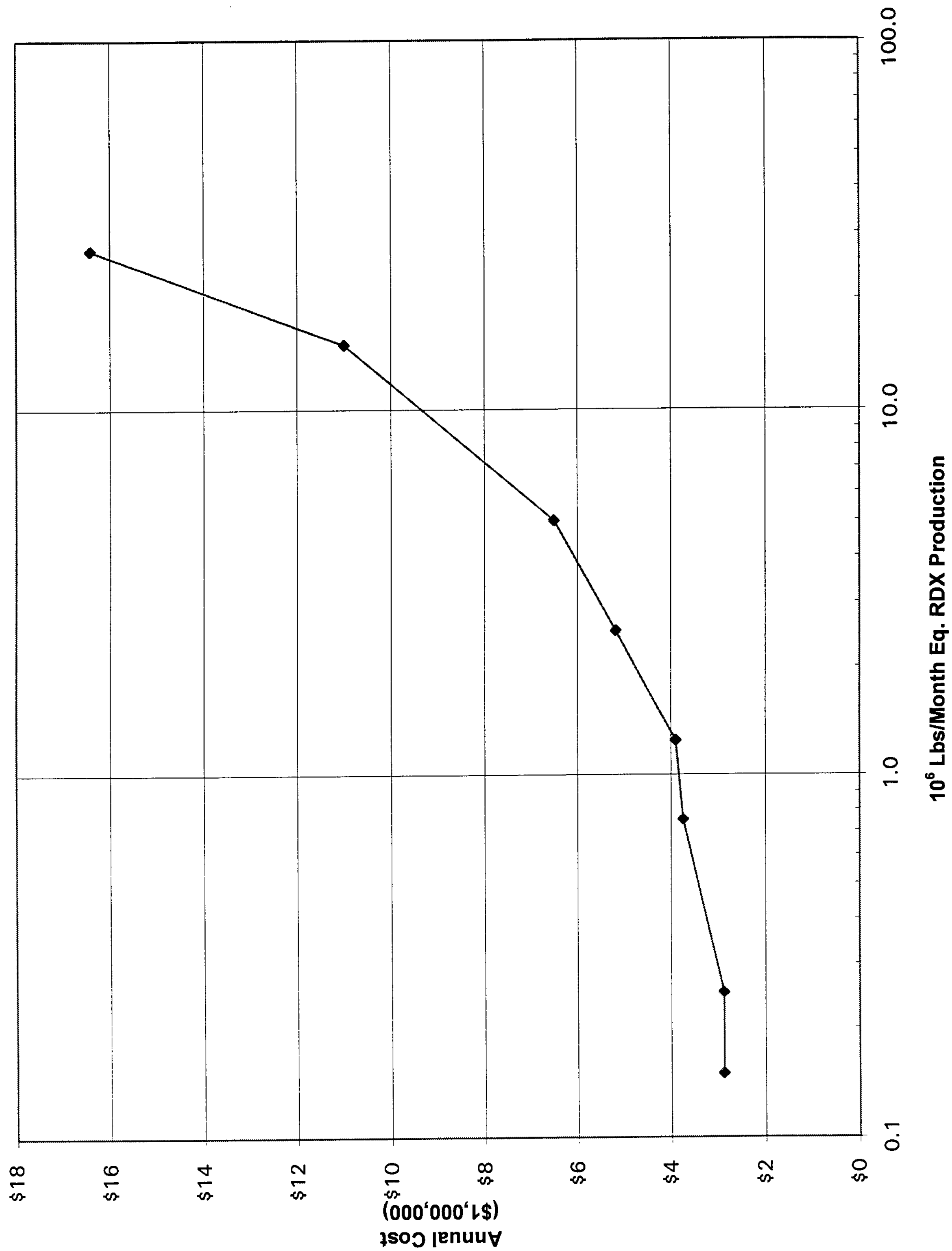
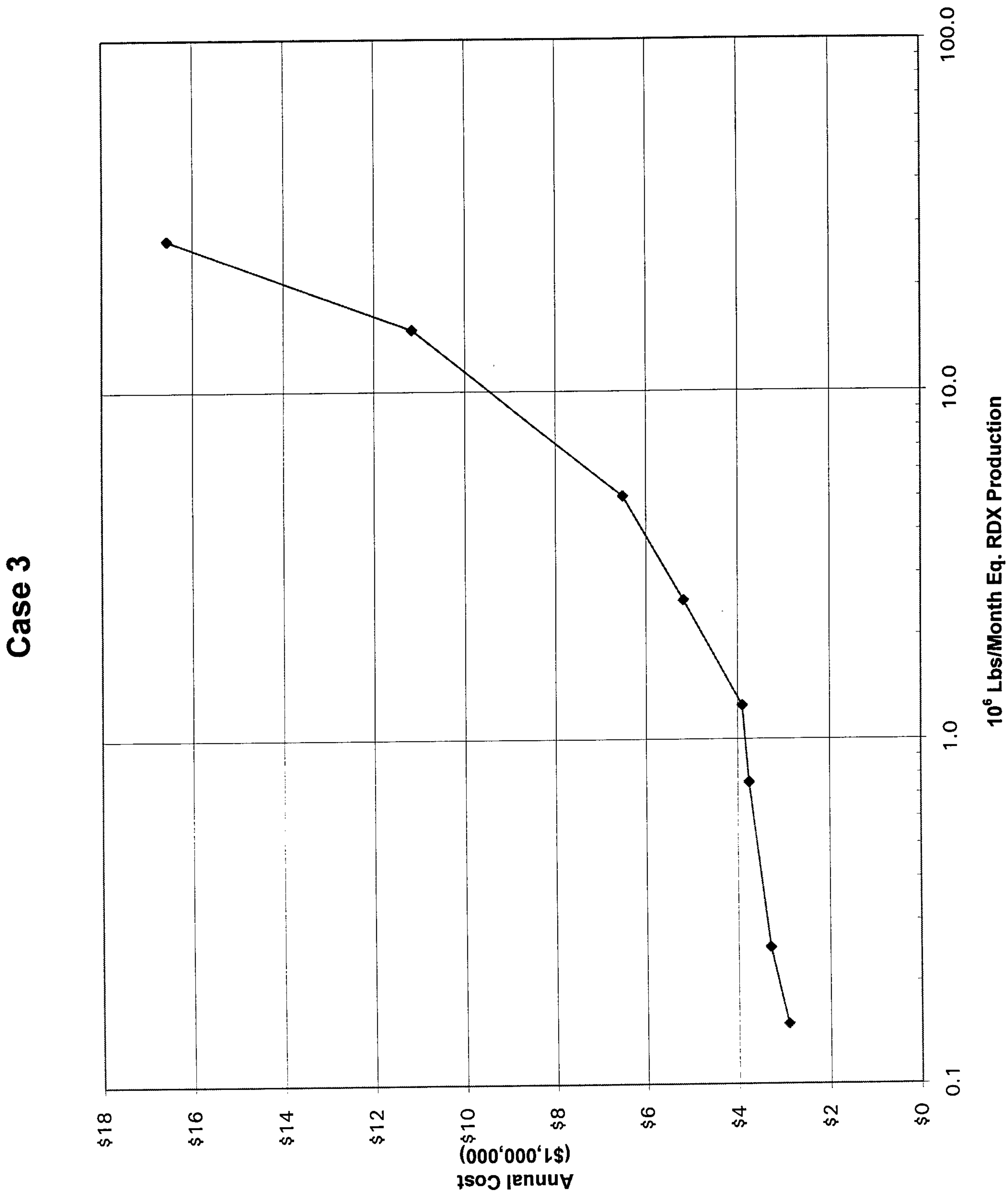


Table 3

CASE NO.3: ONE CASE NO.2 BOILER RETROFIT W/ N.G.BURNER						
MILL. #/MO. EQUIV. RDX	$/MILL. BTU	STEAM BTU/#	# STEAM PER #RDX	STEAM TURB-INE #/HR	STEAM AVG.#/HR	BOILER EFFIC.
0.15	3.95	1290.20	110.00	1629.66	22602.74	77.00
0.25	3.95	1290.20	85.00	2098.80	29109.59	77.90
0.75	1.86	1290.20	65.00	4814.90	66780.82	76.80
1.25	1.86	1290.20	42.00	5185.27	71917.81	78.00
2.50	1.86	1290.20	33.00	16296.58	113013.70	83.10
5.00	1.86	1290.20	20.50	20247.26	140410.96	78.00
15.00	1.86	1290.20	13.00	57778.77	267123.29	79.00
27.00	1.86	1290.20	11.50	122668.77	425342.47	82.00
MILL. #/MO. EQUIV. RDX	FUEL MILL. BTU/MO	ANNUAL FUEL COST	ANNUAL ELECT. COST	ANNUAL; MNTNC. COST	ANNUAL OVRHD. COST	TOTAL ANNUAL COST
0.15	25,504	$1,208,903.14	$266,883.54	$549,000.00	$889,500.00	$2,914,286.68
0.25	32,467	$1,538,933.18	$277,692.45	$577,500.00	$903,750.00	$3,297,875.63
0.75	75,550	$1,686,271.64	$340,270.35	$742,500.00	$986,250.00	$3,755,291.99
1.25	80,110	$1,788,046.62	$348,803.70	$765,000.00	$997,500.00	$3,899,350.32
2.50	118,161	$2,637,345.70	$507,784.20	$945,000.00	$1,087,500.00	$5,177,629.90
5.00	156,404	$3,490,948.15	$804,623.40	$1,065,000.00	$1,147,500.00	$6,508,071.55
15.00	293,784	$6,557,248.71	$1,560,573.00	$1,620,000.00	$1,425,000.00	$11,162,821.71
27.00	450,679	$10,059,163.99	$2,418,811.92	$2,313,000.00	$1,771,500.00	$16,562,475.91

Figure 10



Case 3
$0
$2
$4
$6
$8
$10
$12
$14
$16
$18
Annual Cost
($1,000,000)
0.1
1.0
10.0
100.0
10^6 Lbs/Month Eq. RDX Production

Life Cycle Analysis Summary

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 95046
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.080
INSTALLATION & LOCATION: HOLSTON AAP REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: 95046-00 LIMITED ENERGY STUDY
FISCAL YEAR 1996 DISCRETE PORTION NAME: CASE 3:N.G. BRNR. IN COAL BLR.
ANALYSIS DATE: 10-26-95 ECONOMIC LIFE 15 YEARS PREPARED BY: P. D. LITTLE

1. INVESTMENT

A. CONSTRUCTION COST	$ 65000.	
B. SIOH	$ 3575.	
C. DESIGN COST	$ 3900.	
D. TOTAL COST (1A+1B+1C)	$ 72475.	
E. SALVAGE VALUE OF EXISTING EQUIPMENT	$ 0.	
F. PUBLIC UTILITY COMPANY REBATE	$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)		$ 72475.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 10.25	-22676.	$ -232429.	12.43	$ -2889093.
B. DIST	$ .00	0.	$ 0.	13.56	$ 0.
C. RESID	$ .00	0.	$ 0.	15.09	$ 0.
D. NAT G	$ 3.95	*******	$-1189345.	15.86	$-18863010.
E. COAL	$ 1.86	556056.	$ 1034264.	13.61	$ 14076340.
F. LPG	$ .00	0.	$ 0.	12.64	$ 0.
M. DEMAND SAVINGS			$ 0.	11.85	$ 0.
N. TOTAL		232280.	$ -387510.		$ -7675769.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 114300.
(1) DISCOUNT FACTOR (TABLE A) 11.85
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 1354455.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 1354455.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ -273210.

5. SIMPLE PAYBACK PERIOD (1G/4) -.27 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ -6321314.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= -87.22
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): N/A

Case 4 scenario represents operation with natural gas fired steam boilers, relocated from the Volunteer Army Ammunition Plant (VAAP), and with feedwater pumps and river water pumps turbine driven. VAAP boiler FD fans are electric driven. Results of changing the appropriate input parameters are shown in Table 4 and Figure 11 herein. LCCID Analysis Summary for Case 4 follows on page 32.

Case 5 scenario is similar to Case 4, with all pumps electric driven rather than turbine driven. Results of changing the appropriate input parameters are shown in Table 5 and Figure 12 herein. LCCID analysis summary for Case 5 follows on page 35.

Case 6 scenario represents system operation utilizing a new boiler producing 100 psig saturated steam, with the existing 400 psig steam production and distribution system "layed away" for future return to service as required. The new system includes new deaerating heater-feed pump set and packaged firetube 850 bhp boiler with dual fuel (natural gas and No. 2 oil) capability. An above ground 200,000 gallon oil storage tank is also included.

Case 7 represents systems identical to Case 6, but with fixed maintenance at the upper limit of assumed value (one third of costs for relocated VAAP units) and with fixed overhead at the upper limit of assumed value ($50,000).

Case 8 is a further extension of the above, with fixed costs incrementally increased until the resultant SIR was below the ECIP qualifying value of 1.25.

Table 6 shows results of Both Case 6 and Case 7.

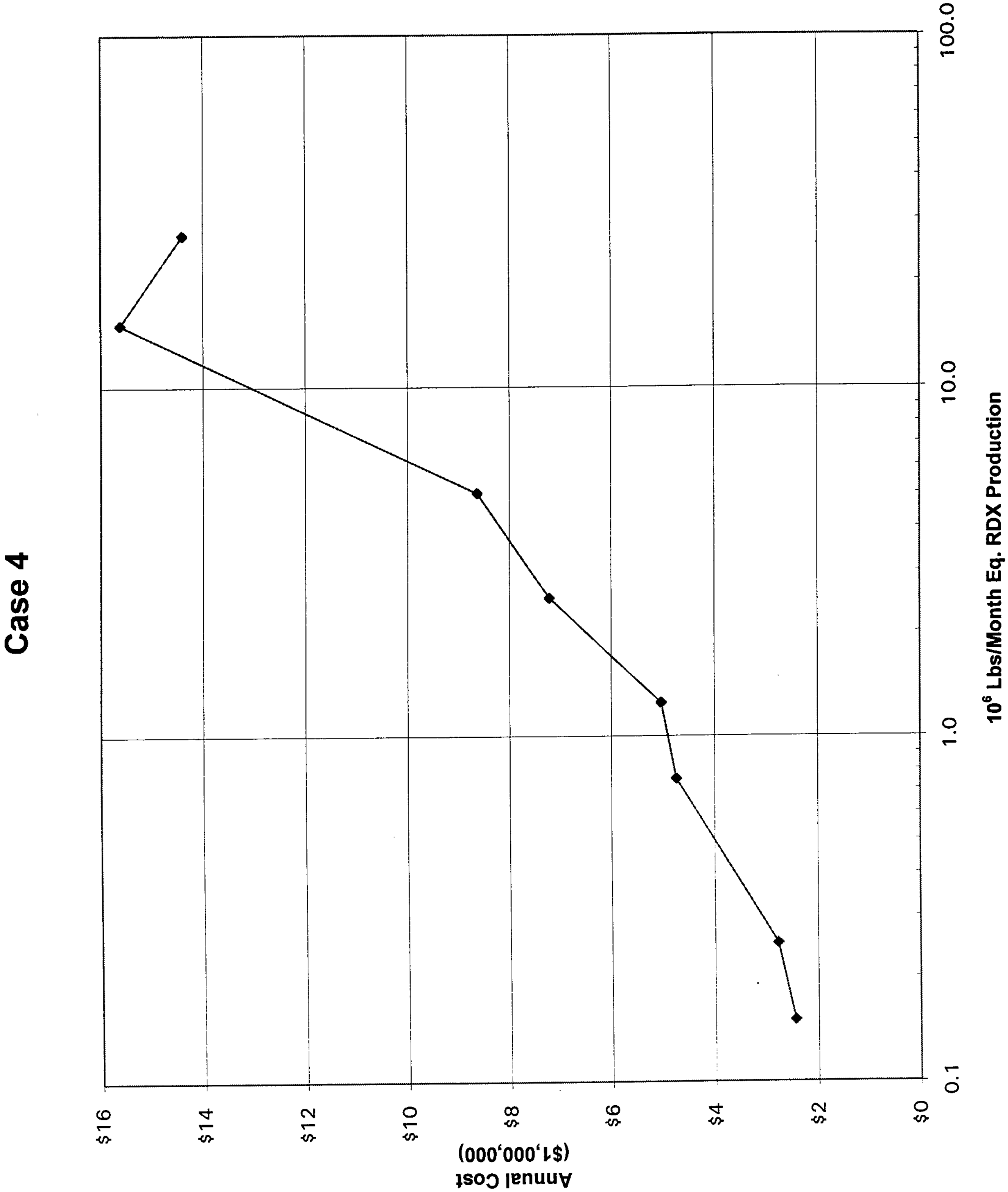
LCCID analysis summaries for Cases 6, 7 and 8 follow on pages 37, 38, and 39.

Total annual operating cost data shows that Case No. 4: VAAP natural gas boilers, with river water and boiler feedwater pumps turbine driven, and Case Nos 6 and 7: New 100 psig boiler offer annual cost savings over the baseline, and only then at explosive production rates below approximately 2.4 million pounds per year (±200,000 lbs/mo equivalent RDX).

Table 4

CASE NO. 4: VAAP N. G. BLRS. W/ RIV. WTR. & BLR. FD. PMPS TURBINE DRIVEN						
MILL. #/MO. EQUIV. RDX	$/MILL. BTU	STEAM BTU/#	# STEAM PER #RDX	STEAM TURB-INE #/HR	STEAM AVG.#/HR	BOILER EFFIC.
0.15	3.95	1204.00	118.57	37256.62	37256.62	78.00
0.25	3.95	1204.00	91.63	37762.39	37762.39	78.50
0.75	3.95	1204.00	70.07	40690.37	71988.45	81.00
1.25	3.95	1204.00	45.28	41089.63	77526.03	81.80
2.50	3.95	1204.00	35.57	53067.40	121826.61	82.50
5.00	3.95	1204.00	22.10	57326.16	151360.34	83.20
15.00	3.95	1204.00	14.01	133284.41	287953.81	82.00
27.00	1.86	1290.20	11.50	122668.77	425342.47	82.00
MILL. #/MO. EQUIV. RDX	FUEL MILL. BTU/MO	ANNUAL FUEL COST	ANNUAL ELECT. COST	ANNUAL; MNTNC. COST	ANNUAL OVRHD. COST	TOTAL ANNUAL COST
0.15	25,173	$1,193,210.90	$56,719.09	$273,955.19	$921,591.99	$2,445,477.18
0.25	32,215	$1,526,978.38	$56,866.41	$274,619.78	$922,699.63	$2,781,164.21
0.75	71,626	$3,395,065.05	$66,835.44	$319,592.83	$997,654.71	$4,734,174.98
1.25	76,381	$3,620,466.21	$68,448.37	$326,869.20	$1,009,782.00	$5,025,565.77
2.50	119,009	$5,641,031.16	$81,351.80	$385,080.17	$1,106,800.28	$7,214,263.41
5.00	146,616	$6,949,587.66	$89,954.09	$423,887.48	$1,171,479.14	$8,634,908.37
15.00	283,009	$13,414,647.26	$129,739.67	$603,371.31	$1,470,618.85	$15,618,377.09
27.00	450,679	$10,059,163.99	$2,418,811.92	$2,313,000.00	$1,771,500.00	$16,562,475.91

Figure 11


Case 4
Annual Cost
($1,000,000)
$16
$14
$12
$10
$8
$6
$4
$2
$0
0.1
1.0
10.0
100.0
10^6 Lbs/Month Eq. RDX Production

LCCID Analysis Summary

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 95046
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.080
INSTALLATION & LOCATION: HOLSTON AAP REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: 95046-00 LIMITED ENERGY STUDY
FISCAL YEAR 1996 DISCRETE PORTION NAME: CASE 4:VAAP N.G.BLRS./ TURB. PMPS
ANALYSIS DATE: 10-27-95 ECONOMIC LIFE 15 YEARS PREPARED BY: P. D. LITTLE

1. INVESTMENT

A. CONSTRUCTION COST	$ 350000.		
B. SIOH	$ 27500.		
C. DESIGN COST	$ 30000.		
D. TOTAL COST (1A+1B+1C)	$ 407500.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 407500.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 10.25	-2182.	$ -22366.	12.43	$ -278003.
B. DIST	$ .00	0.	$ 0.	13.56	$ 0.
C. RESID	$ .00	0.	$ 0.	15.09	$ 0.
D. NAT G	$ 3.95	*******	$-1193200.	15.86	$-18924160.
E. COAL	$ 1.86	556056.	$ 1034264.	13.61	$ 14076340.
F. LPG	$ .00	0.	$ 0.	12.64	$ 0.
M. DEMAND SAVINGS			$ 0.	11.85	$ 0.
N. TOTAL		251798.	$ -181302.		$ -5125825.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)		$ 357255.
(1) DISCOUNT FACTOR (TABLE A)	11.85	
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$ 4233472.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
1. BLR. LAYUP	$-225000.	0	1.00	-225000.
d. TOTAL	$-225000.			-225000.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 4008472.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 160953.

5. SIMPLE PAYBACK PERIOD (1G/4) 2.53 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ -1117353.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= -2.74
(IF < 1 PROJECT DOES NOT QUALIFY)

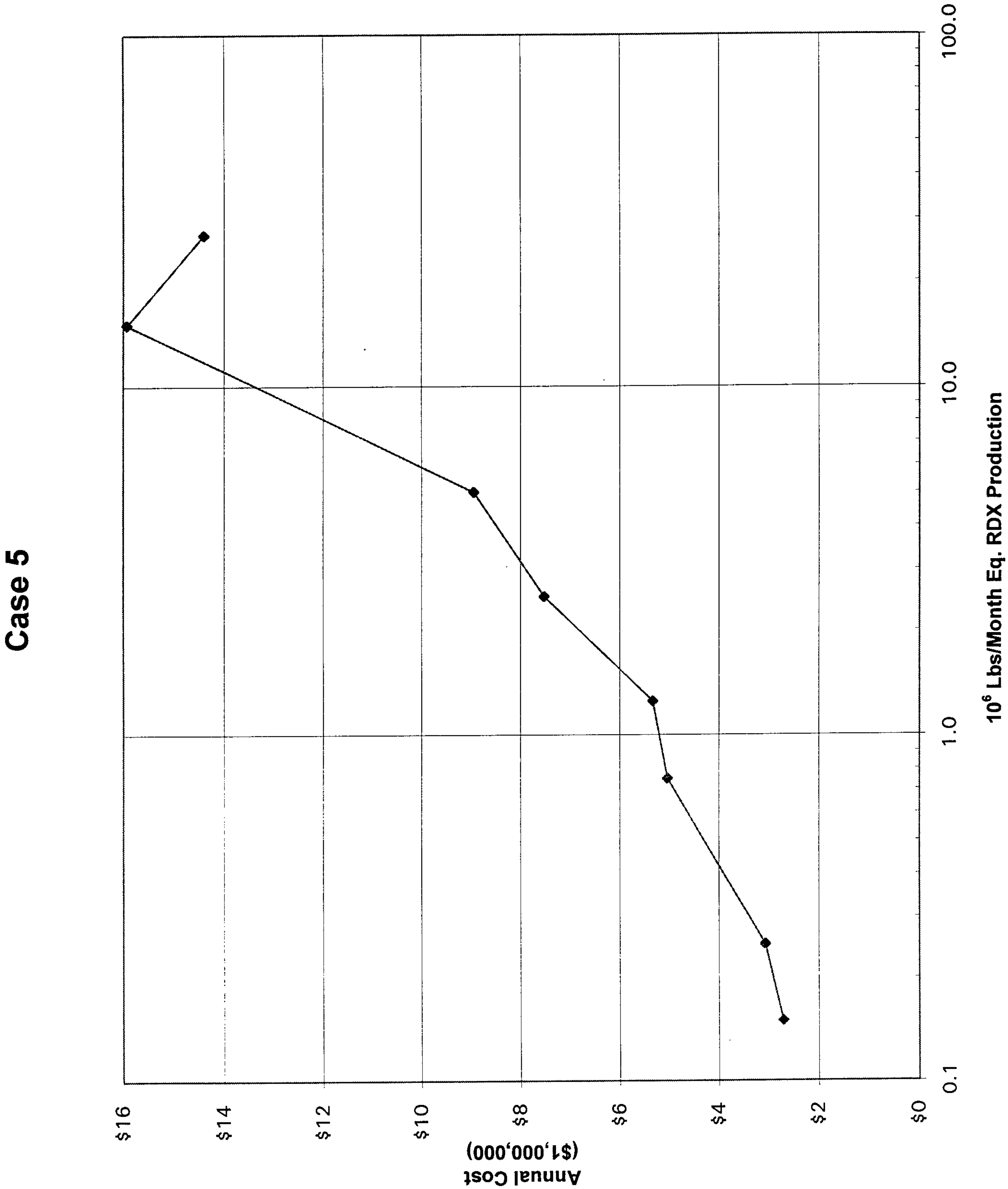
**** Project does not qualify for ECIP funding; 4,5,6 for information only.

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): N/A

Table 5

CASE NO. 5: VAAP N.G. BLRS. W/ PUMPS ELECTRIC DRIVEN						
MILL. #/MO. EQUIV. RDX	$/MILL. BTU	STEAM BTU/#	# STEAM PER #RDX	STEAM TURB-INE #/HR	STEAM AVG.#/HR	BOILER EFFIC.
0.15	3.95	1204.00	118.57	0.00	24363.60	78.00
0.25	3.95	1204.00	91.63	0.00	31378.51	78.50
0.75	3.95	1204.00	70.07	0.00	71988.45	81.00
1.25	3.95	1204.00	45.28	0.00	77526.03	81.80
2.50	3.95	1204.00	35.57	0.00	121826.61	82.50
5.00	3.95	1204.00	22.10	0.00	151360.34	83.20
15.00	3.95	1204.00	14.01	0.00	287953.81	82.00
27.00	1.86	1290.20	11.50	122668.77	425342.47	82.00
MILL. #/MO. EQUIV. RDX	FUEL MILL. BTU/MO	ANNUAL FUEL COST	ANNUAL ELECT. COST	ANNUAL; MNTNC. COST	ANNUAL OVRHD. COST	TOTAL ANNUAL COST
0.15	25,173	$1,193,210.90	$362,568.43	$257,013.78	$893,356.29	$2,706,149.40
0.25	32,215	$1,526,978.38	$364,611.66	$266,231.36	$908,718.93	$3,066,540.33
0.75	71,626	$3,395,065.05	$376,440.12	$319,592.83	$997,654.71	$5,035,391.23
1.25	76,381	$3,620,466.21	$378,053.05	$326,869.20	$1,009,782.00	$5,335,170.45
2.50	119,009	$5,641,031.16	$390,956.48	$385,080.17	$1,106,800.28	$7,523,868.09
5.00	146,616	$6,949,587.66	$399,558.77	$423,887.48	$1,171,479.14	$8,944,513.05
15.00	283,009	$13,414,647.26	$439,344.35	$603,371.31	$1,470,618.85	$15,927,981.77
27.00	450,679	$10,059,163.99	$2,418,811.92	$2,313,000.00	$1,771,500.00	$16,562,475.91

Figure 12



Case 5
Annual Cost ($1,000,000)
$16
$14
$12
$10
$8
$6
$4
$2
$0
0.1
1.0
10.0
100.0
10^6 Lbs/Month Eq. RDX Production

LCCID Analysis Summary

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 95046
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.080
INSTALLATION & LOCATION: HOLSTON AAP REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: 95046-00 LIMITED ENERGY STUDY
FISCAL YEAR 1996 DISCRETE PORTION NAME: CASE 5: VAAP N. G. BLRS/ ELECT PMPS.
ANALYSIS DATE: 10-27-95 ECONOMIC LIFE 15 YEARS PREPARED BY: P. D. LITTLE

1. INVESTMENT

A. CONSTRUCTION COST	$ 350000.		
B. SIOH	$ 27500.		
C. DESIGN COST	$ 30000.		
D. TOTAL COST (1A+1B+1C)	$ 407500.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 407500.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 10.25	-32007.	$ -328072.	12.43	$ -4077932.
B. DIST	$ .00	0.	$ 0.	13.56	$ 0.
C. RESID	$ .00	0.	$ 0.	15.09	$ 0.
D. NAT G	$ 3.95	*******	$-1193200.	15.86	$-18924160.
E. COAL	$ 1.86	556056.	$ 1034264.	13.61	$ 14076340.
F. LPG	$ .00	0.	$ 0.	12.64	$ 0.
M. DEMAND SAVINGS			$ 0.	11.85	$ 0.
N. TOTAL		221973.	$ -487008.		$ -8925753.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 402431.
(1) DISCOUNT FACTOR (TABLE A) 11.85
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 4768808.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
1. BLR. LAYUP	$-225000.	0	1.00	-225000.
d. TOTAL	$-225000.			-225000.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 4543808.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ -99577.

5. SIMPLE PAYBACK PERIOD (1G/4) -4.09 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ -4381946.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= -10.75
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): N/A

Table 6

CASE NO. 6: NEW 30,000#/HR, 100PSIG, N.G.FIRED BOILER @ MIN. FIXED MNTNC & OVRHD						
MILL. #/MO. EQUIV. RDX	$/MILL. BTU	STEAM BTU/#	# STEAM PER #RDX	STEAM TURB-INE #/HR	STEAM AVG.#/HR	BOILER EFFIC.
0.15	3.95	1187.20	120.41	0.00	24741.86	84.50
0.25	3.95	1187.20	93.04	0.00	31864.52	84.50
MILL. #/MO. EQUIV. RDX	FUEL MIL BTU/MO	ANNUAL FUEL COST	ANNUAL ELECT. COST	ANNUAL; MNTNC. COST	ANNUAL OVRHD. CST	TOTAL ANNUAL COST
0.15	23,238	$1,101,504.66	$334,011.50	$77,510.81	$474,184.68	$1,987,211.65
0.25	29,928	$1,418,604.49	$336,086.12	$86,869.98	$489,783.30	$2,331,343.89

CASE NO.7: NEW 30,000#/HR, 100PSIG, N.G.FIRED BOILER @ MAX. FIXED MNTNC & OVRHD						
MILL. #/MO. EQUIV. RDX	$/MILL. BTU	STEAM BTU/#	# STEAM PER #RDX	STEAM TURB-INE #/HR	STEAM AVG.#/HR	BOILER EFFIC.
0.15	3.95	1187.20	120.41	0.00	24741.86	84.50
0.25	3.95	1187.20	93.04	0.00	31864.52	84.50
MILL. #/MO. EQUIV. RDX	FUEL MIL BTU/MO	ANNUAL FUEL COST	ANNUAL ELECT. COST	ANNUAL; MNTNC. COST	ANNUAL OVRHD. CST	TOTAL ANNUAL COST
0.15	23,238	$1,101,504.66	$334,011.50	$107,510.81	$654,184.68	$2,197,211.65
0.25	29,928	$1,418,604.49	$336,086.12	$116,869.98	$669,783.30	$2,541,343.89

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 95046
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.080
INSTALLATION & LOCATION: HOLSTON AAP REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: 95046-00 LIMITED ENERGY STUDY
FISCAL YEAR 1996 DISCRETE PORTION NAME: CASE 6: NEW 30K #/HR 100PSI BLR
ANALYSIS DATE: 10-27-95 ECONOMIC LIFE 15 YEARS PREPARED BY: P. D. LITTLE

1. INVESTMENT

A. CONSTRUCTION COST	$ 362500.		
B. SIOH	$ 27500.		
C. DESIGN COST	$ 30000.		
D. TOTAL COST (1A+1B+1C)	$ 420000.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 420000.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 10.25	-29236.	$ -299669.	12.43	$ -3724886.
B. DIST	$ .00	0.	$ 0.	13.56	$ 0.
C. RESID	$ .00	0.	$ 0.	15.09	$ 0.
D. NAT G	$ 3.95	*******	$-1101481.	15.86	$-17469490.
E. COAL	$ 1.86	556056.	$ 1034264.	13.61	$ 14076340.
F. LPG	$ .00	0.	$ 0.	12.64	$ 0.
M. DEMAND SAVINGS			$ 0.	11.85	$ 0.
N. TOTAL		247964.	$ -366886.		$ -7118043.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 1001105.
(1) DISCOUNT FACTOR (TABLE A) 11.85
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 11863100.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
1. PLNT LAYUP	$-250000.	0	1.00	-250000.
d. TOTAL	$-250000.			-250000.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 11613100.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 617552.

5. SIMPLE PAYBACK PERIOD (1G/4) .68 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 4495052.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 10.70
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): N/A

LCCID Analysis Summary

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 95046
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.080
INSTALLATION & LOCATION: HOLSTON AAP REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: 95046-00 LIMITED ENERGY STUDY
FISCAL YEAR 1996 DISCRETE PORTION NAME: CASE NO. 7: NEW 30K #/HR 100PSI BLR
ANALYSIS DATE: 10-27-95 ECONOMIC LIFE 15 YEARS PREPARED BY: P. D. LITTLE

1. INVESTMENT

A. CONSTRUCTION COST	$ 362500.		
B. SIOH	$ 27500.		
C. DESIGN COST	$ 30000.		
D. TOTAL COST (1A+1B+1C)	$ 420000.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 420000.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 10.25	-29236.	$ -299669.	12.43	$ -3724886.
B. DIST	$ .00	0.	$ 0.	13.56	$ 0.
C. RESID	$ .00	0.	$ 0.	15.09	$ 0.
D. NAT G	$ 3.95	*******	$-1101481.	15.86	$-17469490.
E. COAL	$ 1.86	556056.	$ 1034264.	13.61	$ 14076340.
F. LPG	$ .00	0.	$ 0.	12.64	$ 0.
M. DEMAND SAVINGS			$ 0.	11.85	$ 0.
N. TOTAL		247964.	$ -366886.		$ -7118043.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 791106.
(1) DISCOUNT FACTOR (TABLE A) 11.85
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 9374606.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
1. PLNT. LAYUP	$-250000.	0	1.00	-250000.
d. TOTAL	$-250000.			-250000.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 9124606.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 407553.

5. SIMPLE PAYBACK PERIOD (1G/4) 1.03 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 2006563.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 4.78
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): N/A

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 95046
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.080
INSTALLATION & LOCATION: HOLSTON AAP REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: 95046-00 LIMITED ENERGY STUDY
FISCAL YEAR 1996 DISCRETE PORTION NAME: CASE 8:NEW 30K #/HR 100PSI BLR
ANALYSIS DATE: 10-27-95 ECONOMIC LIFE 15 YEARS PREPARED BY: P. D. LITTLE

1. INVESTMENT
A. CONSTRUCTION COST $ 362500.
B. SIOH $ 27500.
C. DESIGN COST $ 30000.
D. TOTAL COST (1A+1B+1C) $ 420000.
E. SALVAGE VALUE OF EXISTING EQUIPMENT $ 0.
F. PUBLIC UTILITY COMPANY REBATE $ 0.
G. TOTAL INVESTMENT (1D - 1E - 1F) $ 420000.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 10.25	-29236.	$ -299669.	12.43	$ -3724886.
B. DIST	$ .00	0.	$ 0.	13.56	$ 0.
C. RESID	$ .00	0.	$ 0.	15.09	$ 0.
D. NAT G	$ 3.95	*******	$-1101481.	15.86	$-17469490.
E. COAL	$ 1.86	556056.	$ 1034264.	13.61	$ 14076340.
F. LPG	$ .00	0.	$ 0.	12.64	$ 0.
M. DEMAND SAVINGS			$ 0.	11.85	$ 0.
N. TOTAL		247964.	$ -366886.		$ -7118043.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 665000.
(1) DISCOUNT FACTOR (TABLE A) 11.85
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 7880251.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
1. PLNT. LAYUP	$-250000.	0	1.00	-250000.
d. TOTAL	$-250000.			-250000.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 7630251.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 281447.

5. SIMPLE PAYBACK PERIOD (1G/4) 1.49 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 512208.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.22
(IF < 1 PROJECT DOES NOT QUALIFY)
**** Project does not qualify for ECIP funding; 4,5,6 for information only.

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): N/A

At equivalent RDX production of 1.8 million pounds per year, total annual cost savings are as follows:

Case 4 - $176,000

Case 6 - $634,200

Case 7 - $424,200

Corresponding energy savings are:

Case 4 - 254 x 10^9 Btu/yr

Case 6 - 277 x 10^9 Btu/yr

Case 7 - 277 x 10^9 Btu/yr

In each of these cases, cost of natural gas burned is greater than the corresponding coal costs, but these increased costs are offset by reduced maintenance and overhead, producing the positive total cost savings.

For the new 30,000 lbs/hr steam boiler, submittal of an Operating Permit Application to the Tennessee Division of Air Pollution Control will be required. In addition, initial compliance tests for particulate emissions and nitrogen oxide emissions will be required. The nitrogen oxide initial compliance test requires monitoring stack gases for 30 successive steam generating unit operating days.

Energy Rate Data

Coal costs were developed from HDC cost center 2230 breakdown dated 11 May 1995 representing April 1995 data, and from steam unit cost calculations for 1994 out-of-pocket expenses prepared by J. Bouchillon and dated 03/29/95. Value used in the LCCID program is $1.86 per million Btu.

Electrical unit costs were calculated from Kingsport Power Company bill for March 1995. No attempt was made to differentiate between energy cost and demand cost for the scenario analyses. Value used in the LCCID program is $10.25 per million Btu (electrical).

Natural gas unit costs were calculated in a similar manner to electrical costs from United Cities Gas Company bill for April 1995. Value used in the LCCID program is $3.95 per million Btu.

Copies of the cost breakdowns, utility bills, and J. Bouchillon calculations are included in Appendix 1.

Conclusion

Energy (Btu) savings and maintenance cost savings resulting from using natural gas to replace coal in Building 8-A at Holston Army Ammunition Plant are not great enough to offset increased energy costs and justify construction costs. Installation of a new 100 psig firetube boiler at a location closer to the major process steam usage point, permitting complete shutdown of Building 8A, is recommended.

Conversion of existing refrigeration equipment from steam driven to electric driven will have no impact on steam system operation. The turbines being removed function as "pressure reducers", each of which are in parallel with river water pump turbines and with a PRV station and desuper-heating station. The parallel equipment to remain has the capability to meet all expected future conditions.

Existing boiler feedwater/condensate return systems at Holston are suitable for operation in conjunction with relocated boilers from VAAP. In reality, there will be insignificant variations from pressures and flows experienced at present when system load is roughly 40,000 #/hr steam demand. Therefore, transporting the ancillary equipment from VAAP and refurbishing that equipment is not justified.

To carry this theme one more step, the cost of adding fuel oil storage as standby for relocated VAAP boilers has not been included since case studies indicate no economical advantage can be realized even without added storage costs. Also, the coal storage at Area "B" can be considered a standby fuel, although its use in "layed away" boilers would dictate an extended time period for transfer to that fuel.

Definitions/Abbreviations

AESE: Affiliated Engineers SE, Inc.

ASME: American Society of Mechanical Engineers

bhp: Boiler Horsepower

ECO: Energy Conservation Opportunity

Energy Conservation Investment Program (ECIP): This is a federal government program which allocates funds for projects which increase energy efficiency.

HDC: Holston Defense Corporation

HSAAP: Holston Army Ammunition Plant

ID/FD Fan: Induced Draft and/or Forced Draft fans used for steam boilers.

Excess Air: A term used to describe the amount of air that is supplied to fossil fired boilers over and above the amount theoretically required for complete combustion.

lb/hr: pounds per hour

lb/mo: pounds per month

Life Cycle Cost in Design (LCCID): Government software package used to evaluate projects for ECIP funding.

MMBtu: million British thermal units

psig: pounds per square inch gauge

RDX: Research Development Explosive

SIR: Savings to Investment Ratio

VAAP: Volunteer Army Ammunition Plant, Chattanooga, Tennessee

A BOILER CONDITION
AND USEFUL LIFE STUDY
FOR
AFFILIATED ENGINEERS SE, INC

AT
VOLUNTEER ARMY AMMUNITION PLANT
CHATTANOOGA, TENNESSEE

Submitted By:

Hartford Steam Boiler
Inspection & Insurance Company
200 Ashford Center North
Suite 300
Atlanta, GA 30338
August 2, 1995
404 928 0788

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INTRODUCTION

During the time period of July 24 through 28, 1994, The Hartford Steam Boiler Inspection and Insurance Company (HSB) performed a Boiler Condition Study on two Babcock & Wilcox water tube boilers located in building 451 at the facilities of the Volunteer Army Ammunition Plant, Chattanooga Tennessee. The objective of this study was to determine the current condition of the two boilers for possible relocation.

The physical condition, description and evaluation is based upon information obtained through visual inspection, nondestructive examination and hydrostatic testing. Subsequent portions of this report contain a description of the boilers, an evaluation of their existing condition, and the inspection techniques utilized.

Also included is a description of the two deaerating tanks and the current condition of the vessels.

Preceding the survey text is a summary of our inspection findings and corresponding suggestions for correction of observed discrepancies.

This study was directed by J.A. Dognazzi, Regional Supervisor Engineering Services assigned to the Atlanta Regional Office of HSB. Should any portion of this report require clarification or elaboration, please feel free to contact Mr. Dognazzi at 404 928 0788.

SUMMARY

As the following text elaborates, the overall physical integrity of these Babcock & Wilcox boilers appears satisfactory (with the exception of several generating tubes) for continued service at a pressure not to exceed the maximum allowable working pressure as stamped on the Manufacturer's Name Plate. A boiler's physical integrity is for the most part dependent on the material's strength and/or remaining material thickness of the drums and tubes. This detailed physical condition evaluation failed to disclose any significant abnormalities in the strength of material, depletion of material thicknesses, or discontinuities in major weldments that could significantly have an adverse effect on the pressure containing properties of any of the boiler's pressure containing components.

Although the integrity of the pressure containing components is acceptable at this time, several observations were made that should receive corrective action or modification prior to putting these boilers into service. Those observations pertain to the boilers pressure containing components. Summary comments pertaining to those observations are contained in the section immediately following, titled Conclusions/Recommendations, with detailed explanations contained throughout remaining portions of this report.

CONCLUSIONS/RECOMMENDATIONS

Those conditions observed requiring attention prior to placing these boilers in service are as follows:

1. The condition of the four safety valves (2 from each boiler) is questionable due to external condition, broken locking seals, leakage through the seat and disk during hydrostatic test, unable to lift valve seat with lifting lever.

   Recommendation: The valves should be sent to a reliable safety valve repair facility in possession of a valid VR Certificate of Authorization for repair, adjustment and sealing.

2. The tubes in the L & M rows of the west boiler, at the rear of the furnace (approximately the last 18 tubes in each row - total 36) have small blisters. The blisters are very small and almost discernable. The exact cause of the blistering is not known at this time.

   Recommendation: Prior to putting the west boiler into operation, these tubes should be replaced.

   Additionally, the remaining tubes in these rows are behind the waterwall tubes, it is virtually impossible to determine if any of these tube are also blistered.

   Recommendation: Perform a metallurgical analysis on a blistered tube to identify the cause of the blistering. Procedures can be provided for the removal of the tube, shipping and laboratory services upon request.

3. The casing should be removed from both boilers and both economizers to ensure no corrosion has effected the inner components and to properly inspect the insulation.

   Recommendation: The casing on both boilers and economizers should be cleaned of all corrosion/rust and preserved with an approved weather resistant paint designed for high temperature surfaces.

4. The east boiler's economizer has indications of previous leakage as noted in the base of the chimney.

<u>Recommendation:</u> The economizer should be hydrostatically tested to a pressure not to exceed the maximum allowable working pressure as stamped on the vessel.

5. Waterwall tubes of the west boiler - Flame impingement of both walls in the furnace.

<u>Recommendation:</u> The burner flame pattern should be investigated to determine the cause of the impingement. Consideration should be given to performing a burner alignment and a flame pattern analysis to determine cause.

Failure to correct this problem could cause tube failure due to mild prolonged overheating.

6. Scale deposits within the tubes and drums.

<u>Recommendation:</u> The boilers should be cleaned of the scale deposits using any method that will not remove any thickness from the tubes or drums. A recommended method would be high pressure water washing of the tubes and drums.

BOILER DESCRIPTION

These Babcock and Wilcox boilers (2) are bent tube, watertube boilers, manufactured originally for Atlas Chemical Industries, Inc at the Volunteer Army Ammunition Plant (VAAP), Chattanooga, Tennessee. Construction was in accordance with the ASME Code, Section 1, Power Boilers, 1968 Edition with addenda to 12/70. This fact is documented on the Manufacturer's Data Report, a copy of which is contained in Appendix B.

These boilers consist of one steam drum, one mud drum and one bank of generating tubes. Appendix D contains a representative layout of all the tubes in the boilers from the steam drum.

The west boiler is considered a left hand boiler (as the furnace is on the left) and the east boiler is a right hand.

The ASME Code stamping is located on the steam drum's head and normally would be included in this report, as the possibility that asbestos insulation may be installed, the insulation was not disturbed to view the stamping on the drums, therefore, the Manufacturer's Name Plate data is presented as being representative of the ASME construction of the boilers:

West Boiler	East Boiler
Manf: Babcock & Wilcox Co.	Manf: Babcock & Wilcox Co.
Contract No: FM-2126	Contract No: FM-2126
Capacity,lb/hr: 150,000	Capacity,lb/hr: 150,000
Design Pressure: 375 psi	Design Pressure: 375 psi
Steam Temp, F: 442 F	Steam Temp, F: 442 F
Blr H.S. Sq.Ft: 8167 Sq.Ft.	Blr H.S. Sq.Ft.: 8167 Sq.Ft.
Year Built: 1972	Year Built: 1972
Nat'l Bd: 23635	Nat'l Bd: 23636

The ASME "S" stamp is also indicated on both name plate.

The following pertinent information reflects the construction details, documented on the Manufacturer's Data Report, for the major components of these boilers upon which their overall physical integrity is predominately dependent; namely the steam drum, mud drum and tubes.

Steam Drum

Nominal diameter:	48"
Overall length:	32' 1.5625"
Design thickness:	
tubesheet:	1.53125" (1 17/32")
shell plate:	.90625" (29/32")
Material:	SA-515-70
Longitudinal joint:	2-fusion welded/90% efficiency
Circumferential Joints:	2-fusion welded/90% efficiency
Tube hole efficiencies:	
Longitudinal:	35.68%
Circumferential:	31.63%
Diagonal:	39.24%
Heads:	Dished, 1.1875" (1 3/16"), SA-515-70

Mud Drum

Nominal Diameter:	24"
Overall Length:	30' 6.1250"
Design thickness:	.8750" (29/32")
Material:	SA-515-70
Longitudinal Joint:	90%
Circumferential Joint:	4-fusion welded/90% efficiency
Tube hole efficiencies:	
Longitudinal:	42.73%
Circumferential:	19.98%
Heads:	Dished, .75" (.750"), SA-515-70

Tubes

Generating:	2" x .095", SA-178-A
Waterwall:	2" x .134", SA-178-A
	2" x .095", SA-178-A
	2.75" x .165" SA-178-A
	2" x .165", SA-178-A

We understand all pressure containing components are original and that no weld repairs have been made to any pressure retaining component in either boiler, or any tube/s had been replaced or plugged. As reported, operating pressures and temperatures were limited to a operation of 290 psi with no high pressure or high temperature; excessive high water or low water excursions being reported. Additionally, as reported, there had not been any periods of over firing of the boilers.

We further understand these boilers were operated primarily on natural gas constituting 90 % usage with an occasional period on #2 oil.

INSPECTION DETAILS

The inspection of these B & W boilers consisted of a thorough internal and external visual inspection supplemented by ultrasonic thickness measurements of various waterwall tubes. Additional inspection techniques included dry powder magnetic particle examination of the weld joints in all drums and Remote Field Eddy Current (RFEC) examination of twenty five percent of the generating tubes of each boiler.

All the tubes examined are identified within the boxes on the Boiler Tube Layout sheets. These areas were selected due to being the most likely for tube problems to develop either from over heating or external general corrosion from low temperatures. The center section was examined to get a general indication of the tubes. There were no tube thickness loss which would be cause for concern at this time.

While basic comments relative to all inspection techniques will be contained within this section of the report, specific details pertaining to the ultrasonic thickness testing and the RFEC examination of the generating tubes are presented in Appendix C.

During the process of conducting our survey, the following observations were noted reflecting the existing condition of these boilers. Each boilers components will be addressed separately.

The installed internals for both steam drums consist of a row of baffle plates which extend the full length of the drum and cover the last couple of row of tubes. The baffles plates are properly installed, not bowed or otherwise damaged. The piping within the drum consists of a surface blow line, feed line and dry pipe. The piping is properly installed. There is no separators installed in these steam drums. Additionally, there are no internal components installed in the mud drums.

Numerous ultrasonic thickness measurements were taken on the shell, tubesheet and heads of the steam and mud drums from each boiler to identify any possibility of thinning due to corrosion. All the thickness measurements taken were above the nominal thicknesses indicated on the Manufacturer's Data Report.

There were three containers of a desiccant material located on each end of all 4 drums. The containers were removed and were noted to have been last changed anywhere from 1987 to 1990. The desiccant material appeared to be slightly saturated with moisture in that the pellets were a pink to white color as opposed to being blue.

The safety valves on both boilers were painted, including the spring. The safety valves were very difficult to open with the lifting levers. Rust buildup was noted on the spindle where it passes through the tension adjusting nut.

The safety valve name plates revealed the following:

North valve - Manufactured by:	Consolidated
Type:	1811 NA-20
Size:	4" x 4"
Set pressure:	355 psi
Capacity:	74,525 lbs/hr
South valve - Manufactured By:	Consolidated
Type:	1811 PA-20
Size:	4" x 4"
Set pressure:	360 psi
Capacity:	111,039 lbs/hr

All 4 safety valves have broken locking seals, this condition renders the safety valves unreliable for future operation.

West Boiler Steam Drum

The visual inspection of the internal components of the steam drum failed to identify any conditions that would be considered serious. Some small scale deposits were noted throughout the top portion of the tubes and around the tube ends. The deposits were flaking off the tube metal and accumulating in the mud drum. As the RFEC probe was inserted into the tubes, additional deposits were scrapped of and settling in the steam drum. The amount of deposits indicate the tubes are in need of a good cleaning, most preferable is the high pressure water jet method.

The surface of the shell and all components within the drum was noted to have a light coating of surface rust. There was no significant corrosion noted any where within the drum.

The tube ends were not eroded or corroded nor were any split tube ends noted. Minor pitting was noted through out the drum and on some of the tube ends. The pitting is not considered serious.

To perform the RFEC examination of the tubes, they were identified from the front of the boiler (burner end) by numbering from 1 through 97 and lettered circumferentially from top to bottom, A to M. Therefore, the A-1 tube is located in the top right corner of the steam drum when facing the flue gas outlet of the boiler with the burner on the right.

The tubes within the dotted lines on the Boiler Tube Layout sheets were noted to have small blisters on many of the tubes. The blisters were first noted during the RFEC examination of those tubes with an indication of a change in permeability of the tube metal. Further investigation within the furnace revealed the blistering.

West Boiler Mud Drum

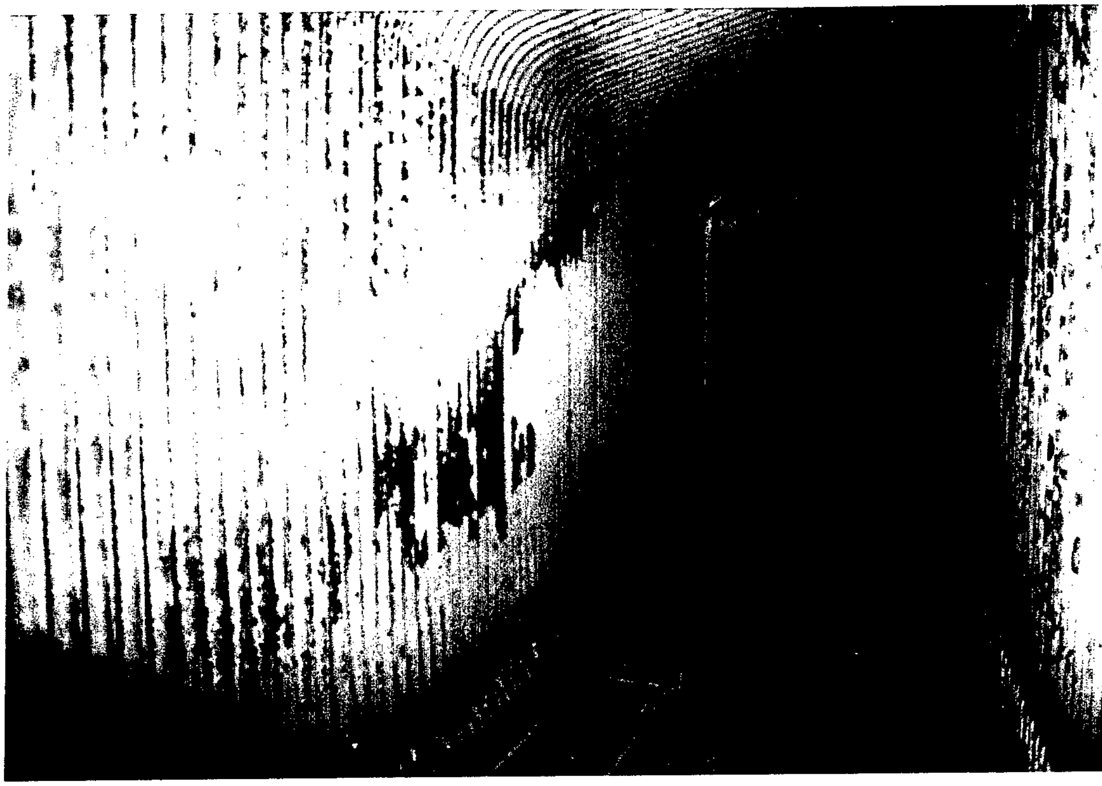
The internal visual inspection noted a significant quantity of loose deposits laying in the drum. The deposits appear to be from the tubes which has flaked off over the years. The quantity of deposits also appear to contain a sand like material, there was no indication how the sand like material got into the boiler.

The waterside surfaces have a slight scale like deposit adhered to the shell and heads, this is not considered significant and a water blast cleaning would most likely remove the deposits. Where the deposits had flaked off, a slight amount of surface corrosion was noted. This is not considered serious.

West Boiler Fireside

The inspection of the firesides was limited to the furnace area. The refractory within the furnace appears to be in satisfactory condition. There were no "soft spots", loose walls, severely broken brick, extremely spalled castable, or significant holes in the refractory noted.

The waterwall and generating tubes were noted to have a coating of fireside deposits which could be removed by brushing. The tube surfaces have a limited amount of general surface corrosion. The waterwall tubes on both sides were noted to have a "carbon pattern" impingement from the burner flame. The pattern was more predominate on the left wall. See photograph next page.



The tubes appeared to be straight with no sagging, warping or other physical distortions noted except the tubes in the beginning of the second pass (as indicated in the dotted red border on the Boiler Tube Layout sheet - identified as L & M rows). Many of these tubes have small blisters which are almost invisible to the naked eye. The cause of the blisters could not readily be determined but a primary source of this type of condition is related to overheating, either mild prolonged overheating or, the boiler experienced a momentary water circulation problem during high firing conditions.

See photograph next page.

The tubes in the L & M row, and possibly other rows, located behind the water wall tubes could also have been effected by the same cause. As these tubes can not be closely examined, it is not know if these tubes have been effected.

Ultrasonic thickness measurements were taken on the waterwall tubes within the furnace area. The measurements taken were at or above the thicknesses identified on the Manufacturer's Data Report. The actual thickness measurements are illustrated in Appendix E.

Additional pictures are located in Appendix F.

West Boiler External Surface

The external condition of the west boiler is satisfactory with some general corrosion noted on the casing, primarily on the top but also on the sides at the top and bottom of both sides. The one concern is that moisture has gotten under the casing and some corrosion may have developed on the inner surfaces.

See photograph next page.

The casing of the economizer of this boiler has several areas where corrosion has come through the metal. The corrosion may have been the result of moisture getting behind the casing. There was no inspection activity of the economizer's pressure retaining components.

The base of the chimney, beneath the economizer tubes was entered with no indication of any leakage being noted.

West Boiler General Notes

1. The surface corrosion within the steam and mud drums is believed to be the result of the desiccant material not being rejuvenated periodically.

West Boiler Hydrostatic Test

The boiler was hydrostatically tested in accordance with the requirements of the National Board Inspection Code (NBIC) and ASME Code, Section 1, Power Boilers, applicable paragraphs. The purpose of the hydrostatic test was to determine the tightness of the rolled and welded joints. The test pressure of 480 psi was attained with no leakage of any tube or welded joint.

During the hydrostatic test, there were numerous valves and one safety valve leaking through that could not be isolated. The leaking safety valve was gagged to prevent the valve from lifting under pressure.

East Boiler Steam Drum

The visual inspection of the internal components of the steam drum failed to identify any conditions that would be considered serious. The conditions noted are basically the same as the west drum in that some minor scale deposits were noted throughout the top portion of the tubes and around the tube ends. The deposits are flaking off the tube metal and accumulating in the mud drum. During the RFEC examination, additional deposits was scrapped off and settled in the mud drum. The amount of deposits indicate the tubes are in need of a good cleaning, most preferable is the high pressure water jet method.

The surface of the shell and all components displayed a light coating of surface rust. There was no significant corrosion noted within the drum.

The condition of the tube ends are essentially the same as the tubes in the west boiler.

The tubes were numbered and lettered in the same manner as the west boiler with the exception the A-1 tube is in the upper left corner when facing the flue gas outlet and the burner is on the left.

East Boiler Mud Drum

The internal visual inspection noted a significant quantity of loose deposits laying in the drum. The deposits appear to be from the tubes which has flaked off over the years. The quantity of deposits also appear to contain a sand like material, there was no indication how the sand like material got into the boiler.

The waterside surfaces have a slight scale like deposit adhered to the shell and heads, this is not considered serious and most likely could be removed with high pressure water cleaning.

East Boiler Firesides

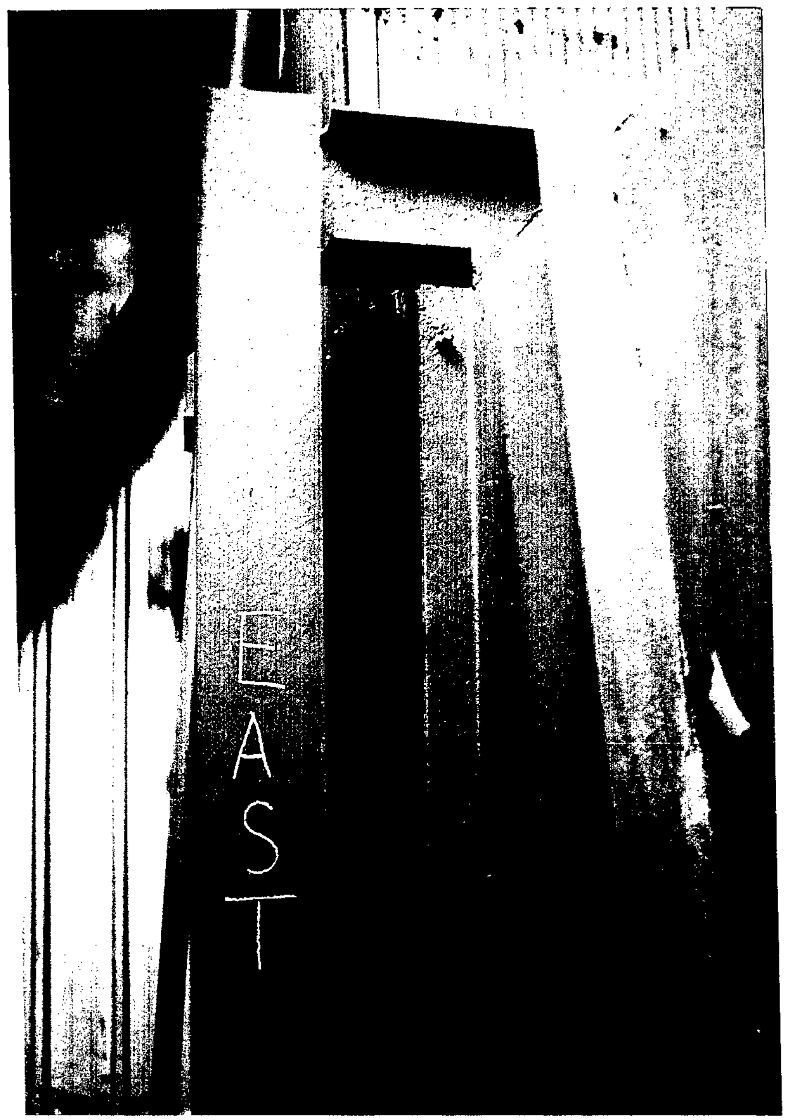
The inspection of the firesides was limited to the furnace area. The refractory within the furnace appears to be in satisfactory condition. There were no "soft spots", loose walls, severely broken fire brick, extremly spalled castable, or holes in the refractory.

The waterwall and generating tubes were noted to have a coating of fireside deposits which could be removed by wiping. The tube surfaces have a slight amount of surface rust which is not a concern at this time. There were no warping, sagging or other physical distortions of the tubes.

East Boiler External Surfaces

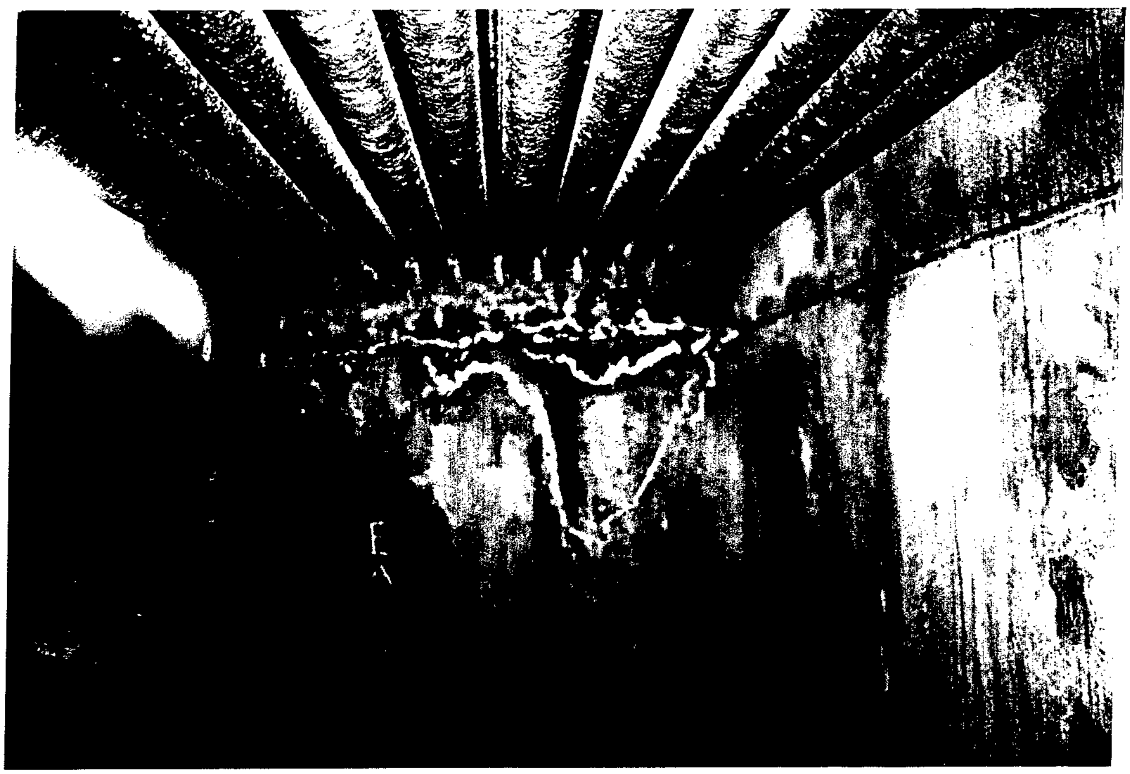
The external condition of the east boiler is satisfactory with some general corrosion noted on the sides and top of the boiler. The concern is moisture may have gotten under the casing and corrosion may have developed on the inner surfaces.

The casing of the economizer has several areas where corrosion has come through the metal. The corrosion may most likely is moisture getting under the casing. There was no inspection activity of the economizer pressure retaining components.



The base of the chimney was entered to investigate the cause of the water stains noted on the rear wall. There was no noted failed tube or welded joint. The possibility of a leaking tube in the tube bank should be considered and corrective action taken.

Photograph view of the lower row of economizer tubes and inner casing. Note white water mark and pattern of corrosion (heavy on the rear wall, light on the side walls). Possibly these indications are the result of leakage within the economizer tube bank.



East Boiler Hydrostatic Test

A hydrostatic test was applied to this boiler in accordance with the requirements of the National Board Inspection Code and ASME Code, Section 1, Power Boilers, applicable paragraphs. The test pressure could only be raised to 280 psi due to numerous valves leaking through that could not be blanked off. Under this pressure, there were no tubes or welded joints leaking.

APPENDIX A

CALCULATIONS

The tubes in the boilers examined with RFEC were 2" x .095" wall thickness, SA-178-A material with a tensile value of 11,500 psi at 700 degree F. The original MAWP of the tubes was 530 psi.

The following indicates the actual wall thickness for each 10 % of wall loss.

Percent -	10 %	20 %	30 %	40 %	50 %
.095" -	.0855	.076	.0665	.057	.0475

The following equation is given in paragraph P-22 (a) and is used to determine the maximum allowable working pressure (MAWP) of tubes.

$$P = S \times \frac{2t - .01D - 2e}{D - (t - .005D - e)}$$

Where:

P = Maximum Allowable Working Pressure, psi

D = Outside diameter, inches

S = Stress value, psi

t = Minimum required thickness, inches

e = Thickness factor for expanded tubes

For the 2" x .095 tubes, a 10 % wall loss equates to a calculated thickness of .0855". To determine the MAWP of a tube with a 10 % wall loss, the following calculation is performed:

$$P = 11500 \times \frac{2 \times .0855 - .01 \times 2 - 2 \times 0.4}{2 - (.0855 - .005 \times 2 - 0.4)} = 415 \text{ psi}$$

Tubes with a 20 % wall loss = 302 psi

The calculated MAWP of tubes with a maximum of 10 % wall loss does not take into consideration any pitting, overheating or other physical conditions which could further reduce the MAWP.

The tubes from 10 to 20 % wall loss are indicated in RED on the Boiler Tube Layout sheets. The tubes with a 10 % or less wall loss are indicated in white.

APPENDIX B

MANUFACTURER'S DATA REPORTS

FORM P-3 MANUFACTURERS' DATA REPORT FOR WATER-TUBE BOILERS, SUPERHEATERS, WATERWALLS, AND ECONOMIZERS

201-2126 **As Required by the Provisions of the ASME Code Rules**

1. Manufactured by The Babcock & Wilcox Company Barberton, Ohio
(Name and address of manufacturer) Chattanooga, Tennessee

2. Manufactured for Atlas Chemical Industries, Inc., Volunteer Army Ammo Plant,
(Name and address of purchaser)
Integral Furnace

3. Identification Bent Tube Boiler (Type of boiler, superheater, waterwall, economizer) Boiler No. BW-23635 (Mfrs. Serial No.) ______ (State and State No.) 23635 (Natl. Board No.) Year Built 1972

4. The chemical and physical properties of all parts meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The design, construction, and workmanship conform to ASME Rules, Section I (I or IV) Dated Addenda 12-31-70 1968

Remarks: Manufacturers' Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of this report: ______
(Name of Part—Item number, manufacturer's name, and identifying stamp)
Boiler Assembled & Tested In Shop

We certify the statement in this data report to be correct.

Date January 28, 19 72 Signed The Babcock & Wilcox Co. (Manufacturer) By R E Lowe (Representative)

Certificate of Authorization Expires December 31, 19 73

CERTIFICATE OF SHOP INSPECTION

BOILER MADE BY The Babcock & Wilcox Company at Wilmington, North Carolina

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors ~~and/or the State or Province of~~ ______ and employed by The Hartford S. B. I. & I. Co. of Hartford, Connecticut

have inspected parts of this boiler referred to as data items 5a, 5b, 6b, 9a, 10 and 11 and have examined manufacturer's partial data reports for items ______ and state that, to the best of my knowledge and belief, the manufacturer has constructed this boiler in accordance with the applicable sections of the ASME BOILER AND PRESSURE VESSEL CODE.

By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the boiler described in this manufacturer's data report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date MAY 4 1972 19 ______

[signature] Inspector Commissions NB-5271 Nat'l Board or State and No.

We certify that the field assembly of all parts of this boiler conforms with the requirements of SECTION I or IV of the ASME BOILER AND PRESSURE VESSEL CODE.

Date ______ 19 ______ Signed ______ (Assembler) By ______ (Representative)

Our Certificate of Authorization to use the ______ (A) or (S) Symbol expires ______ 19 ______

CERTIFICATE OF FIELD ASSEMBLY INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province of ______ and employed by ______ of ______ have compared the statements in this manufacturer's data report with the described boiler and state that the parts referred to as data items ______, not included in the certificate of shop inspection have been inspected by me and that to the best of my knowledge and belief the manufacturer and/or the assembler has constructed and assembled this boiler in accordance with the applicable sections of the ASME BOILER AND PRESSURE VESSEL CODE. The described boiler was inspected and subjected to a hydrostatic test ______ psi.

By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the boiler described in this manufacturer's data report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date ______ 19 ______

______ Inspector Commissions ______ Nat'l Board or State and No.

5(a) Drums 201-2126

No.	Nominal diameter, in.	Length Ft In.	Shell plates: Brand	Shell plates: Material spec. no.	Shell plates: Thickness	Shell plates: Inside radius	Tube sheets: Thickness	Tube sheets: Inside radius	Tube hole ligament efficiency: Longitudinal	Tube hole ligament efficiency: Circumferential
	24	30--6 1/8	PVQ	SA-515-70	7/8	12	7/8	12	.4273	.1998
2									Diag.	.3924
3	48	32--1 5/8	PVQ	SA-515-70	29/32	24	1 17/32	23 11/16	.3568	.3163
4										
5										

No.	Longitudinal joints: No. & type *	Longitudinal joints: Efficiency	Circum. joints: No. & type	Circum. joints: Efficiency	Heads: Brand	Heads: Material spec. no.	Heads: Thickness	Heads: Thickness	Heads: Type**	Heads: Radius of dish	Heads: Manholes No. Size	Hydrostatic test, lb
1	1 #2	.90	4 #2	.90	PVQ	SA-515-70	3/4	3/4	#3	--	2--12x16	
2												
3	2 #2	.90	2 #2	.90	PVQ	SA-515-70	1 3/16	1 3/16	#3	--	2--12x16	
4												
5												

*Indicate if (1) Seamless; (2) Fusion welded; (3) Forge welded; (4) Riveted. **Indicate if (1) Flat; (2) Dished; (3) Ellipsoidal; (4) Hemispherical.

5(b) Boiler Tubes

Diameter	Thickness	Material specification no.
2	.134	SA-178 A
2	.095	SA-178 A

5(c) Headers No. ______ (Box or sinuous; Mat. spec. no.; Thickness)

Heads or Ends ______ (Shape; Mat. spec. no.; Thickness) Hydro. Test, Lb ______

5(d) Staybolts ______ (Mat. spec. no.; Diameter; Size telltale; Net area)

Pitch ______ Net Area ______ (Supported by one bolt) Max. A.W.P. ______

5(e) Mud Drum ______ (For sect. header boilers. State Size; Shape; Mat. spec. no.; Thickness) Heads or Ends ______ (Shape; Mat. spec. no.; Thickness) Hydro. Test, Lb ______

Waterwall Headers / 6(b) Waterwall Tubes

No.	Size and shape	Material spec. no.	Thickness	Heads or Ends: Shape	Heads or Ends: Thickness	Heads or Ends: Material spec. no.	Hydro. test, lb	Diameter	Thickness	Material spec. no.
								2	.134	SA-178 A
								2	.095	SA-178 A
								2.75	.165	SA-178 A
								2	.165	SA-178 A

7(a) Economizer Headers / 7(b) Economizer Tubes

8(a) Superheater Headers / 8(b) Superheater Tubes

9(a) Other Parts (1) F.W. Cont. (2) Feed Pipe (3) ______ 9(b) Tubes for Other Parts

1	1.050" OD	SA-106 B	.135"Min							
2	4.5" O.D.	SA-106 B	.295"Min	Flg'd. Ends						
3					No Connections To Item 10 Except As Listed					

10 Openings (1) Steam 1--12" Flange Pad (No., size, and type of nozzles or outlets) (2) Safety Valve 2--4" Flange Pads (No., size, and type of nozzles or outlets)

(3) Blowoff 1--1 1/2" Flange Connection (No., size, and type of nozzles or outlets) (4) Feed 1--4" Flange Connection Steam Head (No., size, type, and location of connections)

		Maximum Allowable Working Pressure	Code Par. and/or Formula on which AWP is Based	Shop hydro. test	Heating Surface
a	Boiler	375	PG27.2.2	563	7095
b	Waterwall			(Assembled	1072
c	Economizer			Boiler)	7883
d	Superheater				
e	Other parts				

Heating surface to be stamped on drum heads.

This heating surface not to be used for determining minimum safety valve capacity.

12 Field hydro. test

FORM P-3 MANUFACTURERS' DATA REPORT FOR WATER-TUBE BOILERS, SUPERHEATERS, WATERWALLS, AND ECONOMIZERS

201-2126

As Required by the Provisions of the ASME Code Rules

1. Manufactured by The Babcock & Wilcox Company Barberton, Ohio
(Name and address of manufacturer) Chattanooga, Tennessee

2. Manufactured for Atlas Chemical Industries, Inc., Volunteer Army Ammo Plant,
Integral Furnace (Name and address of purchaser)

3. Identification Bent Tube Boiler (Type of boiler, superheater, waterwall, economizer) Boiler No. BW-23636 (Mfrs. Serial No.) ______ (State and State No.) 23636 (Natl. Board No.) Year Built 1972

4. The chemical and physical properties of all parts meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The design, construction, and workmanship conform to ASME Rules, Section I (I or IV) Dated 1968 Addenda 12-31-70

Remarks: Manufacturers' Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of this report: ______
(Name of Part—Item number, manufacturer's name, and identifying stamp)

Boiler Assembled & Tested In Shop

We certify the statement in this data report to be correct.

Date January 28, 19 72 Signed The Babcock & Wilcox Co. (Manufacturer) By R E Lowe (Representative)

Certificate of Authorization Expires December 31, 19 73

CERTIFICATE OF SHOP INSPECTION

BOILER MADE BY The Babcock & Wilcox Company at Wilmington, North Carolina

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors ~~and/or the State or Province of~~

and employed by The Hartford S. B. I. & I. Co. of Hartford, Connecticut

have inspected parts of this boiler referred to as data items 5a, 5b, 6b, 9a, 10 and 11 and have examined manufacturer's partial data reports for items ______ and state that, to the best of my knowledge and belief, the manufacturer has constructed this boiler in accordance with the applicable sections of the ASME BOILER AND PRESSURE VESSEL CODE.

By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the boiler described in this manufacturer's data report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date MAY 4 1972 19 ______

[signature] Inspector Commissions NB-5271 Nat'l Board or State and No.

We certify that the field assembly of all parts of this boiler conforms with the requirements of SECTION I or IV of the ASME BOILER AND PRESSURE VESSEL CODE.

Date ______ 19 ______ Signed ______ (Assembler) By ______ (Representative)

Our Certificate of Authorization to use the ______ (A) or (S) Symbol expires ______ 19 ______

CERTIFICATE OF FIELD ASSEMBLY INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province of ______

and employed by ______ of ______

have compared the statements in this manufacturer's data report with the described boiler and state that the parts referred to as data items ______, not included in the certificate of shop inspection have been inspected by me and that to the best of my knowledge and belief the manufacturer and/or the assembler has constructed and assembled this boiler in accordance with the applicable sections of the ASME BOILER AND PRESSURE VESSEL CODE. The described boiler was inspected and subjected to a hydrostatic test ______ psi.

By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the boiler described in this manufacturer's data report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date ______ 19 ______

______ Inspector Commissions ______ Nat'l Board or State and No.

5(a) Drums 201-2126

No.	Nominal diameter, in.	Length Ft	Length In.	Shell plates: Brand	Shell plates: Material spec. no.	Shell plates: Thickness	Shell plates: Inside radius	Tube sheets: Thickness	Tube sheets: Inside radius	Tube hole ligament efficiency: Longitudinal	Tube hole ligament efficiency: Circumferential
1	24	30--6 1/8		PVQ	SA-515-70	7/8	12	7/8	12	.4273	.1998
2										Diag.	.3924
3	48	32--1 5/8		PVQ	SA-515-70	29/32	24	1 17/32	23 11/16	.3568	.3163
4											
5											

No.	Longitudinal joints: No. & type*	Longitudinal joints: Efficiency	Circum. joints: No. & type	Circum. joints: Efficiency	Heads: Brand	Heads: Material spec. no.	Heads: Thickness		Heads: Type**	Heads: Radius of dish	Manholes: No. Size	Hydrostatic test, lb
1	1 #2	.90	4 #2	.90	PVQ	SA-515-70	3/4	3/4	#3	--	2--12x16	
2												
3	2 #2	.90	2 #2	.90	PVQ	SA-515-70	1 3/16	1 3/16	#3	--	2--12x16	
4												
5												

*Indicate if (1) Seamless; (2) Fusion welded; (3) Forge welded; (4) Riveted. **Indicate if (1) Flat; (2) Dished; (3) Ellipsoidal; (4) Hemispherical.

5(b) Boiler Tubes

Diameter	Thickness	Material specification no.
2	.134	SA-178 A
2	.095	SA-178 A

5(c) Headers No. ____ (Box or sinuous; Mat. spec. no.; Thickness)

Heads or Ends ____ (Shape; Mat. spec. no.; Thickness) Hydro. Test, Lb ____

5(d) Staybolts ____ (Mat. spec. no.; Diameter; Size telltale; Net area)

Pitch ____ Net Area ____ (Supported by one bolt) Max. A.W.P. ____

5(e) Mud Drum ____ (For sect. header boilers. State Size; Shape; Mat. spec. no.; Thickness) Heads or Ends ____ (Shape; Mat. spec. no.; Thickness) Hydro. Test, Lb ____

6(a) Waterwall Headers / 6(b) Waterwall Tubes

No.	Size and shape	Material spec. no.	Thickness	Heads or Ends: Shape	Heads or Ends: Thickness	Heads or Ends: Material spec. no.	Hydro. test, lb	Diameter	Thickness	Material spec. no.
								2	.134	SA-178 A
								2	.095	SA-178 A
								2.75	.165	SA-178 A
								2	.165	SA-178 A

7(a) Economizer Headers / 7(b) Economizer Tubes

8(a) Superheater Headers / 8(b) Superheater Tubes

9(a) Other Parts (1) F.W. Cont. (2) Feed Pipe (3) ____ 9(b) Tubes for Other Parts

1	1.050" OD	SA-106 B	.135"Min							
2	4.5" O.D.	SA-106 B	.295"Min	Flg'd. Ends						
3					No Connections To Item 10 Except As Listed					

10 Openings (1) Steam 1--12" Flange Pad (No., size, and type of nozzles or outlets) (2) Safety Valve 2--4" Flange Pads (No., size, and type of nozzles or outlets)

(3) Blowoff 1--1 1/2" Flange Connection (No., size, and type of nozzles or outlets) (4) Feed 1--4" Flange Connection Steam Head (No., size, type, and location of connections)

11

		Maximum Allowable Working Pressure	Code Par. and/or Formula on which AWP is Based	Shop hydro. test	Heating Surface
a	Boiler	375	PG27.2.2	563	7095
b	Waterwall			(Assembled	1072
c	Economizer			Boiler)	7883
d	Superheater				
e	Other parts				

Heating surface to be stamped on drum heads.

This heating surface not to be used for determining minimum safety valve capacity.

12 Field hydro. test

APPENDIX C

REMOTE FIELD EDDY

CURRENT FIELD DATA

THE HARTFORD
STEAM BOILER INSPECTION
AND INSURANCE CO.
Engineering Services

200 Ashford Center North
Suite 300
Atlanta, Georgia 30338
(404) 396-4820

WEST

FIELD DATA REPORT

Customer Affiliated Engineers, S.E. Plant VAAP, Chattanooga, TN Date 7/25/95

Frequency 105 MHz Current 300 ma No. of Channels 3 Sens. 4.8 Ref. Std. Ser. #

Unit No. West Boiler Tube Size 2" Gauge .095 Material SA-178-A

	Row #	Tube #	Plugged	Blocked Obstructed	Wall Loss %								Location/Remarks
					1-10%	11-20%	21-30%	31-40%	41-50%	51-60%	61-70%	70% +	
1	A	1				X							Membrane-thicker tube
2		2			X								
3		3			X								
4		4			X								
5		5			X								
6		6			X								
7		7			X								
8		8			X								
9		9			X								
10		10			X								
11		11			X								
12		12			X								
13		13			X								
14		14			X								
15		15			X								
16		16			X								
17		17			X								
18		18			X								
19		60			X								
20		61			X								
21		62			X								
22		63			X								
23		64			X								
24		65			X								
25	B	1				X							Membrane
26		2			X								
27		3			X								
28		4			X								
29		5			X								
30		6			X								

TOTALS

Probe S/N 0015 Technician Brian Galvan Page 1 of 11

WEST

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.
Engineering Services

200 Ashford Center North
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FIELD DATA REPORT

Customer Affiliated Engineers, S.E. Plant VAAP, Chattanooga, TN Date 7/25/95

Frequency 105 MHz Current 300 ma No. of Channels 3 Sens. 4.8 Ref. Std. Ser. #

Unit No. West Boiler Tube Size 2" Gauge .095 Material SA-178-A

	Row #	Tube #	Plugged	Blocked Obstructed	Wall Loss % 1-10%	11-20%	21-30%	31-40%	41-50%	51-60%	61-70%	70% +	Location/Remarks
1		7			X								
2		8			X								
3		9			X								
4		10			X								
5		11			X								
6		12			X								
7		13			X								
8		14			X								
9		15			X								
10		16			X								
11		17			X								
12		18			X								
13		60			X								
14		61			X								
15		62			X								
16		63			X								
17		64			X								
18		65			X								
19	C	1				X							Membrane
20		2			X								
21		3			X								
22		4			X								
23		5			X								
24		6			X								
25		7			X								
26		8			X								
27		9			X								
28		10			X								
29		11			X								
30		12			X								

TOTALS

Probe S/N 0015 Technician Brian Galvan Page 2 of 11

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FIELD DATA REPORT

Customer Affiliated Engineers, S.E. Plant VAAP, Chattanooga, TN Date 7/25/95

Frequency 105 MHz Current 300 ma No. of Channels 3 Sens. 4.8 Ref. Std. Ser. #

Unit No. West Boiler Tube Size 2" Gauge .095 Material SA-178-A

	Row #	Tube #	Plugged	Blocked Obstructed	Wall Loss % 1-10%	11-20%	21-30%	31-40%	41-50%	51-60%	61-70%	70% +	Location/Remarks
1		13			X								
2		14			X								
3		15			X								
4		16			X								
5		17			X								
6		18			X								
7		60			X								
8		61			X								
9		62			X								
10		63			X								
11		64			X								
12		65			X								
13	D	1				X							Membrane
14		2			X								
15		3			X								
16		4			X								
17		5			X								
18		6			X								
19		7			X								
20		8			X								
21		9			X								
22		10			X								
23		11			X								
24		12			X								
25		13			X								
26		14			X								
27		15			X								
28		16			X								
29		17			X								
30		18			X								

TOTALS

Probe S/N 0015 Technician Brian Galvan Page 3 of 11

WEST

THE HARTFORD
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FIELD DATA REPORT

Customer Affiliated Engineers, S.E. Plant VAAP, Chattanooga, TN Date 7/25/95

Frequency 105 MHz Current 300 ma No. of Channels 3 Sens. 4.8 Ref. Std. Ser. #

Unit No. West Boiler Tube Size 2" Gauge .095 Material SA-178-A

	Row #	Tube #	Plugged	Blocked Obstructed	Wall Loss % 1-10%	11-20%	21-30%	31-40%	41-50%	51-60%	61-70%	70% +	Location/Remarks
1		60			X								
2		61			X								
3		62			X								
4		63			X								
5		64			X								
6		65			X								
7	E	1				X							Membrane
8		2			X								
9		3			X								
10		4			X								
11		5			X								
12		6			X								
13		7			X								
14		8			X								
15		9			X								
16		10			X								
17		11			X								
18		12			X								
19		13			X								
20		14			X								
21		15			X								
22		16			X								
23		17			X								
24		18			X								
25		60			X								
26		61			X								
27		62			X								
28		63			X								
29		64			X								
30		65			X								

TOTALS

Probe S/N 0015 Technician Brian Galvan Page 4 of 11

THE HARTFORD
STEAM BOILER INSPECTION
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Engineering Services

200 Ashford Center North
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WEST

FIELD DATA REPORT

Customer Affiliated Engineers, S.E. Plant VAAP, Chattanooga, TN Date 7/25/95

Frequency 105 MHz Current 300 ma No. of Channels 3 Sens. 4.8 Ref. Std. Ser. #

Unit No. West Boiler Tube Size 2" Gauge .095 Material SA-178-A

	Row #	Tube #	Plugged	Blocked Obstructed	Wall Loss % 1-10%	11-20%	21-30%	31-40%	41-50%	51-60%	61-70%	70% +	Location/Remarks
1	F	1				X							Membrane
2		2			X								
3		3			X								
4		4			X								
5		5			X								
6		6			X								
7		7			X								
8		8			X								
9		9			X								
10		10			X								
11		11			X								
12		12			X								
13		13			X								
14		14			X								
15		15			X								
16		16			X								
17		17			X								
18		18			X								
19		60			X								
20		61			X								
21		62			X								
22		63			X								
23		64			X								
24		65			X								
25		80			X								
26		81			X								
27		82			X								
28		83			X								
29		84			X								
30		85			X								

TOTALS

Probe S/N 0015 Technician Brian Galvan Page 5 of 11

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FIELD DATA REPORT

Customer Affiliated Engineers, S.E. Plant VAAP, Chattanooga, TN Date 7/25/95

Frequency 105 MHz Current 300 ma No. of Channels 3 Sens. 4.8 Ref. Std. Ser. #

Unit No. West Boiler Tube Size 2" Gauge .095 Material SA-178-A

	Row #	Tube #	Plugged	Blocked Obstructed	Wall Loss % 1-10%	11-20%	21-30%	31-40%	41-50%	51-60%	61-70%	70% +	Location/Remarks
1		86			X								
2		87			X								
3		88			X								
4		89			X								
5		90			X								
6		91			X								
7		92			X								
8		93			X								
9		94			X								
10		95			X								
11		96			X								
12		97			X								
13	G	1				X							Membrane
14		2			X								
15		3			X								
16		4			X								
17		5			X								
18		6			X								
19		7			X								
20		8			X								
21		9			X								
22		10			X								
23		11			X								
24		12			X								
25		13			X								
26		14			X								
27		15			X								
28		16			X								
29		17			X								
30		18			X								
TOTALS													

Probe S/N 0015 Technician Brian Galvan Page 6 of 11

WEST

THE HARTFORD
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FIELD DATA REPORT

Customer Affiliated Engineers, S.E. Plant VAAP, Chattanooga, TN Date 7/25/95

Frequency 105 MHz Current 300 ma No. of Channels 3 Sens. 4.8 Ref. Std. Ser. #

Unit No. West Boiler Tube Size 2" Gauge .095 Material SA-178-A

	Row #	Tube #	Plugged	Blocked Obstructed	Wall Loss % 1-10%	11-20%	21-30%	31-40%	41-50%	51-60%	61-70%	70% +	Location/Remarks
1		60			X								
2		61			X								
3		62			X								
4		63			X								
5		64			X								
6		65			X								
7		80				X							General wall loss-midway
8		81			X								
9		82				X							Possible material change
10		83			X								
11		84			X								
12		85			X								
13		86				X							Possible material change
14		87			X								
15		88			X								
16		89			X								
17		90				X							Possible material change
18		91			X								
19		92			X								
20		93			X								
21		94				X							Possible material change
22		95			X								
23		96			X								
24		97				X							Membrane
25	H	60			X								
26		61			X								
27		62				X							Possible material change
28		63			X								
29		64			X								
30		65			X								

TOTALS *Tubes 82, 86, 90, 94 may be of a greater thickness to allow for attachments (soot blower).

Probe S/N 0015 Technician Brian Galvan Page 7 of 11

WEST

THE HARTFORD
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Engineering Services

200 Ashford Center North
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(404) 396-4820

FIELD DATA REPORT

Customer Affiliated Engineers, S.E. Plant VAAP, Chattanooga, TN Date 7/25/95

Frequency 105 MHz Current 300 ma No. of Channels 3 Sens. 4.8 Ref. Std. Ser. # ____

Unit No. West Boiler Tube Size 2" Gauge .095 Material SA-178-A

	Row #	Tube #	Plugged	Blocked Obstructed	Wall Loss % 1-10%	11-20%	21-30%	31-40%	41-50%	51-60%	61-70%	70% +	Location/Remarks
1		80				X							Possible material change
2		81			X								
3		82			X								
4		83			X								
5		84				X							Possible material change
6		85			X								
7		86			X								
8		87			X								
9		88				X							Possible material change
10		89			X								
11		90			X								
12		91			X								
13		92				X							Possible material change
14		93			X								
15		94			X								
16		95			X								
17		96				X							Possible material change
18		97				X							
19	I	60			X								
20		61			X								
21		62			X								
22		63			X								
23		64			X								
24		65			X								
25		80			X								
26		81			X								
27		82			X								
28		83			X								
29		84			X								
30		85			X								

TOTALS *Tubes 62, 80, 84, 88, 92, 96 may be of a greater thickness to allow for attachments (soot blower).

Probe S/N 0015 Technician Brian Galvan Page 8 of 11

WEST

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

Engineering Services

200 Ashford Center North
Suite 300
Atlanta, Georgia 30338
(404) 396-4820

FIELD DATA REPORT

VAAP

Customer Affiliated Engineers, S.E. Plant Chattanooga, TN Date 7/25/95

Frequency 105 MHz Current 300 ma No. of Channels 3 Sens. 4.8 Ref. Std. Ser. # ____

Unit No. West Boiler Tube Size 2" Gauge .095 Material SA-178-A

	Row #	Tube #	Plugged	Blocked Obstructed	Wall Loss % 1-10%	11-20%	21-30%	31-40%	41-50%	51-60%	61-70%	70% +	Location/Remarks
1		86			X								
2		87			X								
3		88			X								
4		89			X								
5		90			X								
6		91			X								
7		92			X								
8		93			X								
9		94			X								
10		95			X								
11		96			X								
12		97				X							Membrane
13	J	60			X								
14		61			X								
15		62			X								
16		63			X								
17		64			X								
18		65			X								
19		80			X								
20		81			X								
21		82			X								
22		83			X								
23		84			X								
24		85			X								
25		86			X								
26		87			X								
27		88			X								
28		89			X								
29		90			X								
30		91			X								

TOTALS

Probe S/N 0015 Technician Brian Galvan

WEST

THE HARTFORD
STEAM BOILER INSPECTION
AND INSURANCE CO.
Engineering Services

200 Ashford Center North
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FIELD DATA REPORT

Customer Affiliated Engineers, S.E. Plant VAAP, Chattanooga, TN Date 7/25/95

Frequency 105 MHz Current 300 ma No. of Channels 3 Sens. 4.8 Ref. Std. Ser. #

Unit No. West Boiler Tube Size 2" Gauge .095 Material SA-178-A

	Row #	Tube #	Plugged	Blocked Obstructed	Wall Loss % 1-10%	11-20%	21-30%	31-40%	41-50%	51-60%	61-70%	70% +	Location/Remarks
1		92			X								
2		93			X								
3		94			X								
4		95			X								
5		96			X								
6		97				X							Membrane
7	K	60			X								
8		61			X								
9		62			X								
10		63			X								
11		64			X								
12		65			X								
13		80				X							Gen. wall loss-low-mid
14		81				X							Gen. wall loss-mid-upper
15		82			X								
16		83			X								
17		84			X								
18		85			X								
19		86			X								
20		87			X								
21		88			X								
22		89			X								
23		90			X								
24		91			X								
25		92				X							Gen. wall loss-upper
26		93			X								
27		94			X								
28		95			X								
29		96			X								
30		97				X							Membrane

TOTALS

Probe S/N 0015 Technician Brian Galvan Page 10 of 11

WEST

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FIELD DATA REPORT

Customer Affiliated Engineers, S.E. Plant VAAP, Chattanooga, TN Date 7/25/95

Frequency 105 MHz Current 300 ma No. of Channels 3 Sens. 4.8 Ref. Std. Ser. #

Unit No. West Boiler Tube Size 2" Gauge .095 Material SA-178-A

	Row #	Tube #	Plugged	Blocked Obstructed	Wall Loss % 1-10%	11-20%	21-30%	31-40%	41-50%	51-60%	61-70%	70% +	Location/Remarks
1	L	60			X								
2		61			X								
3		62			X								
4		63			X								
5		64			X								
6		65			X								
7		80			X								
8		81			X								
9		82				X							Gen. wall loss-low-mid
10		83			X								
11		84			X								
12		85			X								
13		86			X								
14		87			X								
15		88			X								
16		89			X								
17		90			X								
18		91				X							Gen. wall loss-low-mid
19		92			X								
20		93			X								
21		94			X								
22		95			X								
23		96			X								
24		97				X							Membrane
25													
26													
27													
28													
29													
30													

TOTALS *Blisters were noted on L-82 upon subsequent visual inspection.

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EAST

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Frequency 105 MHz Current AC No. of Channels 3 Sens. 4.8 Ref. Std. Ser. # ______

Unit No. East Tube Size 2" Gauge .095 Material SA-178-A

	Row #	Tube #	Plugged	Blocked Obstructed	Wall Loss % 1-10%	11-20%	21-30%	31-40%	41-50%	51-60%	61-70%	70% +	Location/Remarks
1	A	1				X							Membrane
2		2			X								
3		3			X								
4		4			X								
5		5			X								
6		6			X								
7		7			X								
8		8			X								
9		9			X								
10		10			X								
11		11			X								
12		12			X								
13		13			X								
14		14			X								
15		15			X								
16		16			X								
17		17			X								
18		18			X								
19		60			X								
20		61			X								
21		62			X								
22		63			X								
23		64			X								
24		65			X								
25	B	1				X							Membrane
26		2			X								
27		3			X								
28		4			X								
29		5			X								
30		6			X								

TOTALS

Probe S/N 1537128 Technician Brian Galvan Page 1 of 11

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Unit No. East Tube Size 2" Gauge .095 Material SA-178-A

	Row #	Tube #	Plugged	Blocked Obstructed	Wall Loss % 1-10%	11-20%	21-30%	31-40%	41-50%	51-60%	61-70%	70% +	Location/Remarks
1		7			X								
2		8			X								
3		9			X								
4		10			X								
5		11			X								
6		12			X								
7		13			X								
8		14			X								
9		15			X								
10		16			X								
11		17			X								
12		18			X								
13		60			X								
14		61			X								
15		62			X								
16		63			X								
17		64			X								
18		65			X								
19	C	1				X							Membrane
20		2			X								
21		3			X								
22		4			X								
23		5			X								
24		6			X								
25		7			X								
26		8			X								
27		9			X								
28		10				X							Possible pitting midway
29		11			X								
30		12			X								

TOTALS

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Frequency 105 MHz Current AC No. of Channels 3 Sens. 4.8 Ref. Std. Ser. #

Unit No. East Tube Size 2" Gauge .095 Material SA-178-A

	Row #	Tube #	Plugged	Blocked Obstructed	Wall Loss % 1-10%	11-20%	21-30%	31-40%	41-50%	51-60%	61-70%	70% +	Location/Remarks
1		13			X								
2		14			X								
3		15			X								
4		16			X								
5		17			X								
6		18			X								
7		60			X								
8		61			X								
9		62			X								
10		63			X								
11		64			X								
12		65			X								
13	D	1				X							Membrane
14		2			X								
15		3			X								
16		4			X								
17		5			X								
18		6			X								
19		7			X								
20		8			X								
21		9			X								
22		10			X								
23		11			X								
24		12			X								
25		13			X								
26		14			X								
27		15			X								
28		16			X								
29		17			X								
30		18			X								

TOTALS

Probe S/N 1537128 Technician Brian Galvan Page 3 of 11

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Frequency 105 MHz Current AC No. of Channels 3 Sens. 4.8 Ref. Std. Ser. #

Unit No. East Tube Size 2" Gauge .095 Material SA-178-A

	Row #	Tube #	Plugged	Blocked Obstructed	Wall Loss % 1-10%	11-20%	21-30%	31-40%	41-50%	51-60%	61-70%	70% +	Location/Remarks
1		60			X								
2		61			X								
3		62			X								
4		63			X								
5		64			X								
6		65			X								
7	E	1				X							Membrane
8		2			X								
9		3			X								
10		4			X								
11		5			X								
12		6			X								
13		7			X								
14		8			X								
15		9			X								
16		10			X								
17		11			X								
18		12			X								
19		13			X								
20		14			X								
21		15			X								
22		16			X								
23		17			X								
24		18			X								
25		60			X								
26		61			X								
27		62			X								
28		63			X								
29		64			X								
30		65			X								

TOTALS

Probe S/N 1537128 Technician Brian Galvan Page 4 of 11

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Frequency 105 MHz Current AC No. of Channels 3 Sens. 4.8 Ref. Std. Ser. #

Unit No. East Tube Size 2" Gauge .095 Material SA-178-A

	Row #	Tube #	Plugged	Blocked	Wall Loss %								Location/Remarks
				Obstructed	1-10%	11-20%	21-30%	31-40%	41-50%	51-60%	61-70%	70% +	
1	F	1				X							Membrane
2		2			X								
3		3			X								
4		4			X								
5		5			X								
6		6			X								
7		7			X								
8		8			X								
9		9			X								
10		10			X								
11		11			X								
12		12			X								
13		13			X								
14		14				X							Lower
15		15			X								
16		16			X								
17		17			X								
18		18			X								
19		60			X								
20		61			X								
21		62			X								
22		63			X								
23		64			X								
24		65			X								
25		80			X								
26		81			X								
27		82			X								
28		83			X								
29		84			X								
30		85			X								

TOTALS

Probe S/N 1537128 Technician Brian Galvan Page 5 of 11

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Frequency 105 MHz Current AC No. of Channels 3 Sens. 4.8 Ref. Std. Ser. # ______

Unit No. East Tube Size 2" Gauge .095 Material SA-178-A

	Row #	Tube #	Plugged	Blocked Obstructed	Wall Loss % 1-10%	11-20%	21-30%	31-40%	41-50%	51-60%	61-70%	70% +	Location/Remarks
1		86			X								
2		87			X								
3		88			X								
4		89			X								
5		90			X								
6		91			X								
7		92			X								
8		93			X								
9		94			X								
10		95			X								
11		96			X								
12		97				X							Membrane
13	G	1				X							Membrane
14		2			X								
15		3			X								
16		4			X								
17		5			X								
18		6			X								
19		7			X								
20		8			X								
21		9			X								
22		10			X								
23		11			X								
24		12			X								
25		13			X								
26		14			X								
27		15			X								
28		16			X								
29		17			X								
30		18			X								

TOTALS

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Frequency 105 MHz Current AC No. of Channels 3 Sens. 4.8 Ref. Std. Ser. # ____

Unit No. East Tube Size 2" Gauge .095 Material SA-178-A

	Row #	Tube #	Plugged	Blocked Obstructed	Wall Loss % 1-10%	11-20%	21-30%	31-40%	41-50%	51-60%	61-70%	70% +	Location/Remarks
1		60			X								
2		61			X								
3		62			X								
4		63			X								
5		64			X								
6		65			X								
7		80			X								
8		81			X								
9		82				X							Possible material change
10		83			X								
11		84			X								
12		85			X								
13		86				X							Possible material change
14		87			X								
15		88			X								
16		89			X								
17		90				X							Possible material change
18		91			X								
19		92			X								
20		93			X								
21		94				X							Possible material change
22		95			X								
23		96			X								
24		97				X							Membrane
25	H	60			X								
26		61			X								
27		62			X								
28		63			X								
29		64			X								
30		65			X								

TOTALS *Tubes 82, 86, 90, 94 may be of a greater material thickness to allow for attachments (soot blower).

Probe S/N 1537128 Technician Brian Galvan Page 7 of 11

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Frequency 105 MHz Current AC No. of Channels 3 Sens. 4.8 Ref. Std. Ser. # ______

Unit No. East Tube Size 2" Gauge .095 Material SA-178-A

	Row #	Tube #	Plugged	Blocked	Wall Loss %								Location/Remarks
				Obstructed	1-10%	11-20%	21-30%	31-40%	41-50%	51-60%	61-70%	70% +	
1		80				X							Possible material change-
2													attachment
3		81			X								
4		82			X								
5		83			X								
6		84				X							Possible material change-
7													attachment
8		85			X								
9		86			X								
10		87			X								
11		88				X							Possible material change-
12													attachment
13		89			X								
14		90			X								
15		91			X								
16		92				X							Possible material change
17		93			X								
18		94			X								
19		95			X								
20		96			X								
21		97				X							Membrane or change in
22													thickness
23	I	60			X								
24		61			X								
25		62			X								
26		63			X								
27		64			X								
28		65			X								
29		80			X								
30		81			X								

TOTALS *Tubes 80, 84, 88, 92 may be of a greater material thickness to allow for attachment (soot blower).

Probe S/N 1537128 Technician Brian Galvan Page 8 of 11

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Unit No. East Tube Size 2" Gauge .095 Material SA-178-A

	Row #	Tube #	Plugged	Blocked Obstructed	Wall Loss % 1-10%	11-20%	21-30%	31-40%	41-50%	51-60%	61-70%	70% +	Location/Remarks
1		82			X								
2		83			X								
3		84			X								
4		85			X								
5		86			X								
6		87			X								
7		88			X								
8		89			X								
9		90			X								
10		91			X								
11		92			X								
12		93			X								
13		94			X								
14		95			X								
15		96			X								
16		97				X							Membrane
17	J	60			X								
18		61			X								
19		62			X								
20		63			X								
21		64			X								
22		65			X								
23		80			X								
24		81			X								
25		82			X								
26		83			X								
27		84			X								
28		85			X								
29		86			X								
30		87			X								

TOTALS

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Unit No. East Tube Size 2" Gauge .095 Material SA-178-A

	Row #	Tube #	Plugged	Blocked Obstructed	Wall Loss % 1-10%	11-20%	21-30%	31-40%	41-50%	51-60%	61-70%	70% +	Location/Remarks
1		94			X								
2		95			X								
3		96			X								
4		97				X							Membrane
5	L	60			X								
6		61			X								
7		62			X								
8		63			X								
9		64			X								
10		65			X								
11		80			X								
12		81			X								
13		82			X								
14		83			X								
15		84			X								
16		85			X								
17		86			X								
18		87			X								
19		88			X								
20		89			X								
21		90			X								
22		91			X								
23		92			X								
24		93				X							General wall loss
25		94			X								
26		95			X								
27		96			X								
28		97				X							Membrane
29													
30													

TOTALS

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Unit No. East Tube Size 2" Gauge .095 Material SA-178-A

	Row #	Tube #	Plugged	Blocked Obstructed	Wall Loss % 1-10%	11-20%	21-30%	31-40%	41-50%	51-60%	61-70%	70% +	Location/Remarks
1		88			X								
2		89			X								
3		90			X								
4		91			X								
5		92			X								
6		93			X								
7		94			X								
8		95			X								
9		96			X								
10		97				X							Membrane
11	K	60			X								
12		61			X								
13		62			X								
14		63			X								
15		64			X								
16		65			X								
17		80			X								
18		81			X								
19		82			X								
20		83			X								
21		84			X								
22		85			X								
23		86			X								
24		87			X								
25		88			X								
26		89			X								
27		90			X								
28		91			X								
29		92			X								
30		93			X								
TOTALS													

Probe S/N 1537128 Technician Brian Galvan Page 10 of 11

APPENDIX D

BOILER TUBE LAYOUT

APPENDIX E

TUBE THICKNESS

West Boiler Tube Thickness

The following ultrasonic thickness measurements were obtained from the water wall tubes within the furnace area. The tubes were numbered from the front to the rear:

Right (short) Water Wall

Tube #	Loc. 1	Loc. 2	Loc. 3	Loc. 4	
5	.139	.140	.139	.141	
10	.138	.139	.140	.140	
15	.140	.141	.141	.140	Original
20	.139	.142	.139	.139	thickness
25	.138	.140	.139	.139	.134" these
30	.140	.139	.140	.141	tubes.
35	.139	.140	.139	.140	
40	.140	.142	.140	.141	
45	.138	.139	.140	.141	
50	.138	.138	.139	.140	
55	.139	.140	.140	.141	
60	.140	.142	.140	.140	
65	.141	.143	.142	.142	
70	.140	.142	.141	.141	
75	.138	.139	.139	.140	
80	.106	.108	.105	.109	Original
85	.102	.104	.106	.105	thickness
90	.104	.103	.106	.105	.095 these
					tubes

Rear Wall

Tube #	Loc. 1	Loc. 2	Loc. 3	Loc. 4	
2	.138	.137	.139	.140	
4	.139	.139	.138	.139	
6	.137	.139	.137	.138	
8	.136	.138	.138	.139	Original
10	.138	.139	.140	.142	thickness
12	.139	.140	.137	.140	.134" these
14	.136	.138	.139	.138	tubes.
16	.137	.138	.137	.138	
18	.136	.137	.136	.137	
20	.138	.139	.138	.139	

Left (long) Water Wall

Tube #	Loc. 1	Loc. 2	Loc. 3	Loc. 4	
5	.172	.174	.173	.174	
10	.170	.171	.171	.171	
15	.172	.173	.170	.172	
20	.168	.169	.169	.169	
25	.169	.170	.172	.172	Original
30	.169	.171	.171	.172	thickness
35	.170	.171	.172	.172	.165" these
40	.172	.170	.171	.173	tubes.
45	.168	.168	.169	.170	
50	.170	.170	.172	.171	
55	.168	.169	.168	.170	
60	.169	.170	.171	.170	
65	.168	.169	.170	.170	
70	.169	.171	.172	.170	
75	.169	.170	.171	.171	
80	.169	.171	.171	.170	
85	.170	.172	.172	.171	
90	.169	.169	.170	.170	

East Boiler Tube Thickness

Left (short) Water Wall

Tube #	Loc. 1	Loc. 2	Loc. 3	Loc. 4	
1	.136	.134	.139	.135	
6	.139	.140	.139	.140	
11	.135	.136	.133	.134	
16	.138	.137	.139	.140	
21	.136	.134	.137	.137	Original
26	.134	.134	.137	.134	thickness
31	.141	.141	.140	.141	.134 these
36	.138	.140	.141	.142	tubes.
41	.139	.140	.141	.141	
46	.138	.138	.141	.141	
51	.140	.139	.139	.139	
56	.139	.139	.140	.141	
61	.142	.143	.142	.142	
66	.137	.140	.138	.139	
71	.137	.137	.136	.136	
76	.105	.103	.104	.103	Original
81	.100	.102	.101	.101	thickness
86	.105	.106	.106	.107	.095" these
91	.107	.106	.107	.107	tubes.

Right (long) Water Wall

Tube #	Loc. 1	Loc. 2	Loc. 3	Loc. 4	
1	.172	.176	.177	.176	
6	.174	.171	.170	.170	
11	.171	.170	.171	.172	
16	.170	.169	.170	.171	
21	.168	.167	.167	.167	
26	.169	.170	.170	.170	
31	.169	.168	.170	.169	
36	.171	.172	.171	.173	
41	.170	.168	.169	.166	Original
46	.171	.171	.168	.172	thickness
51	.172	.173	.168	.171	.165" these
56	.173	.174	.174	.172	tubes.
61	.172	.172	.170	.170	
66	.168	.170	.168	.169	
71	.169	.168	.168	.170	
76	.167	.169	.168	.168	
81	.169	.171	.172	.171	
86	.170	.171	.172	.173	
91	.171	.172	.171	.171	

Rear Water Wall

Tube #	Loc. 1	Loc. 2	Loc. 3	Loc. 4	
2	.143	.139	.142	.142	
4	.136	.137	.135	.135	
6	.136	.136	.137	.138	
8	.140	.140	.141	.141	Original
10	.135	.136	.135	.136	thickness
12	.138	.141	.141	.140	.134" these
14	.141	.142	.142	.142	tubes
16	.143	.145	.144	.145	
18	.144	.142	.140	.142	
20	.137	.138	.138	.137	

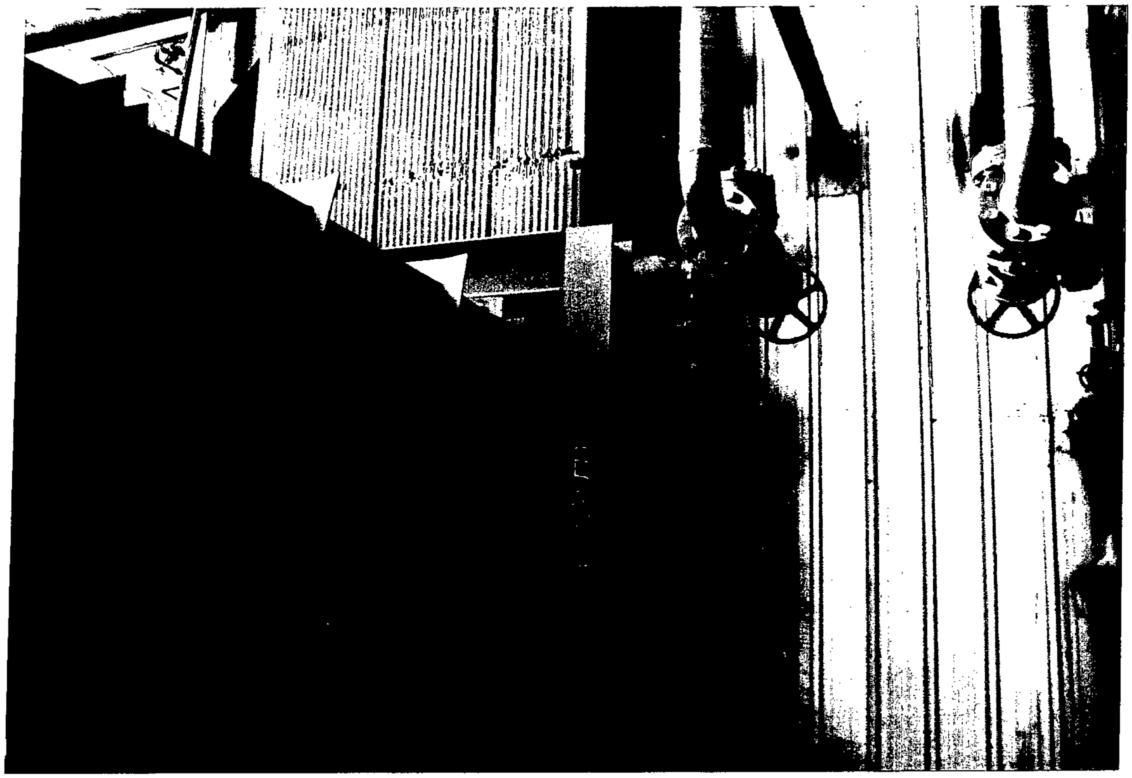
APPENDIX F

BOILER PICTURES

Boiler Photograph Log

Photograph #	Description
1	Casing of east economizer. Notice corrosion is in a straight line pattern at 2 levels.
2	West boiler burner. Staining appears to be from water. Condition of refractory is good.
3	Blister on west boiler tube. Notice length of blister.
4	Another tube in west boiler, this tube is in the 2nd row in.
5	Another tube blister, same boiler.
6	West boiler water wall (left side). Notice degree of carbon buildup. Most likely from improper burner alignment.
7	West boiler water wall (right side). Notice fireside deposits and minimum amount of carbon buildup.
8	West boiler economizer. Notice straight line corrosion at 2 levels.

1



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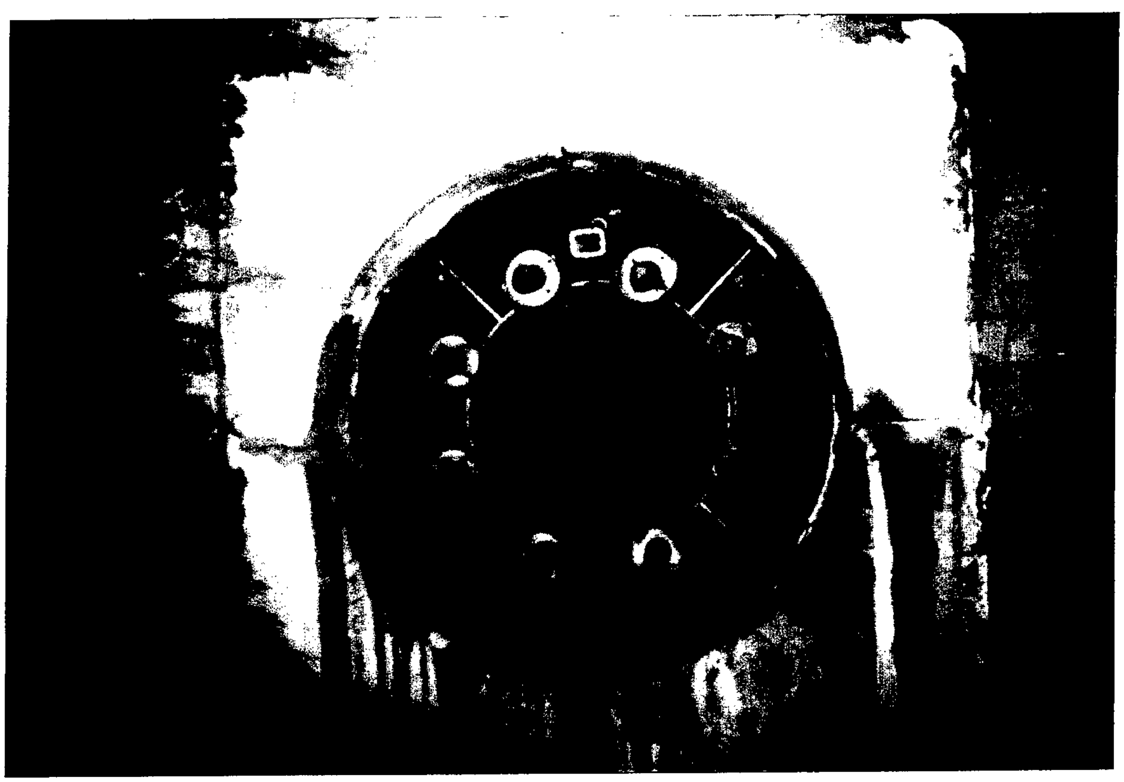

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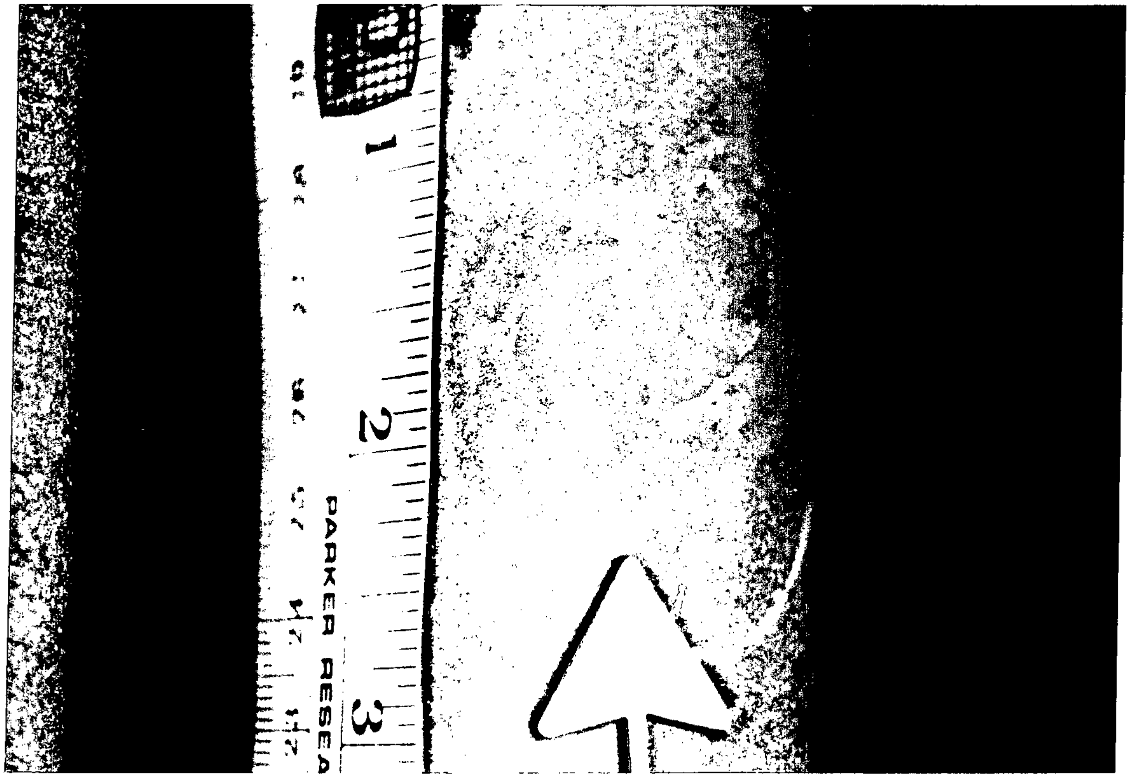

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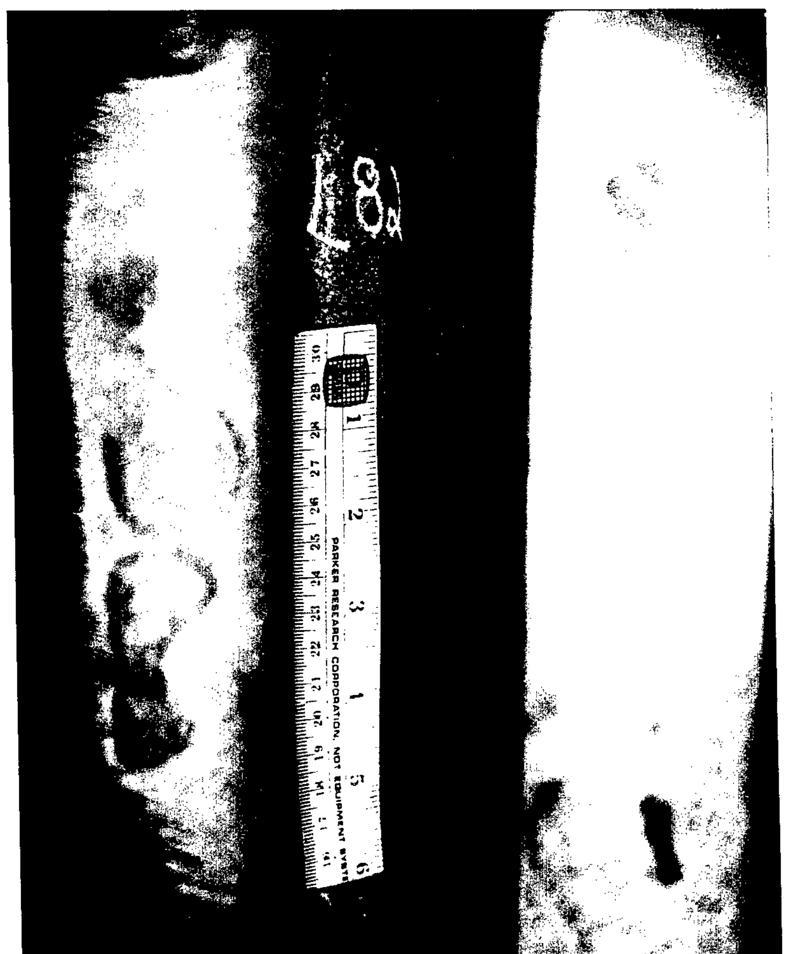

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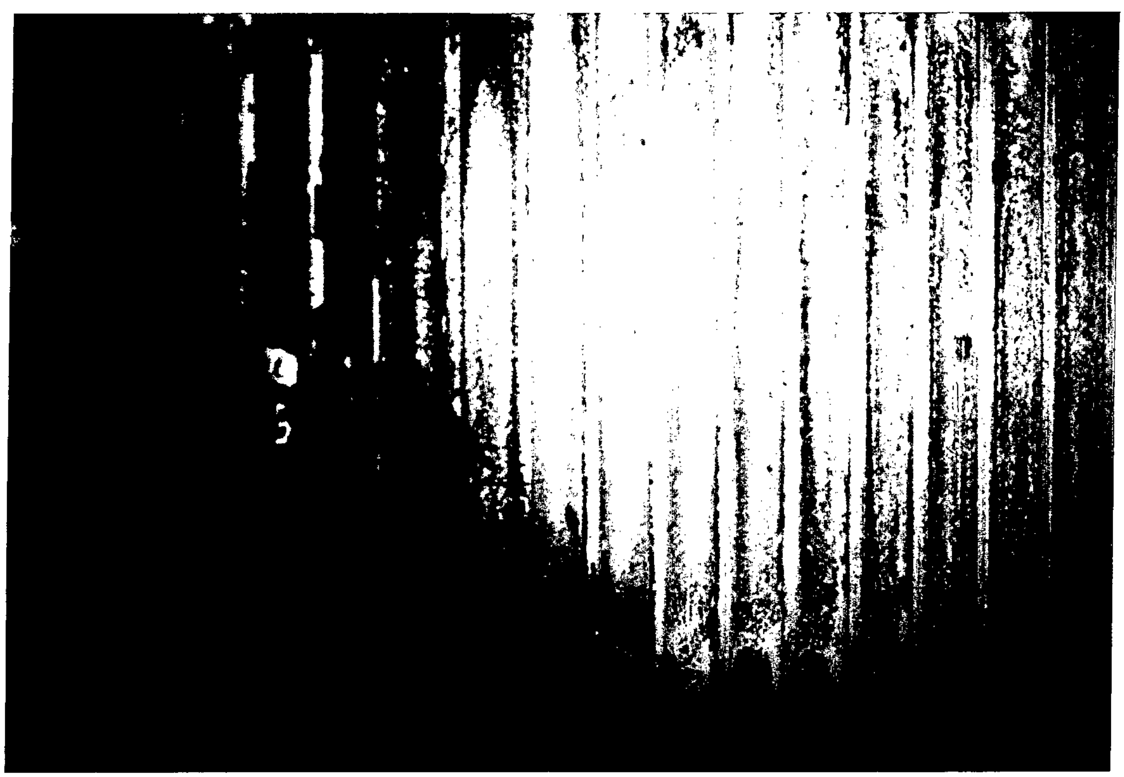

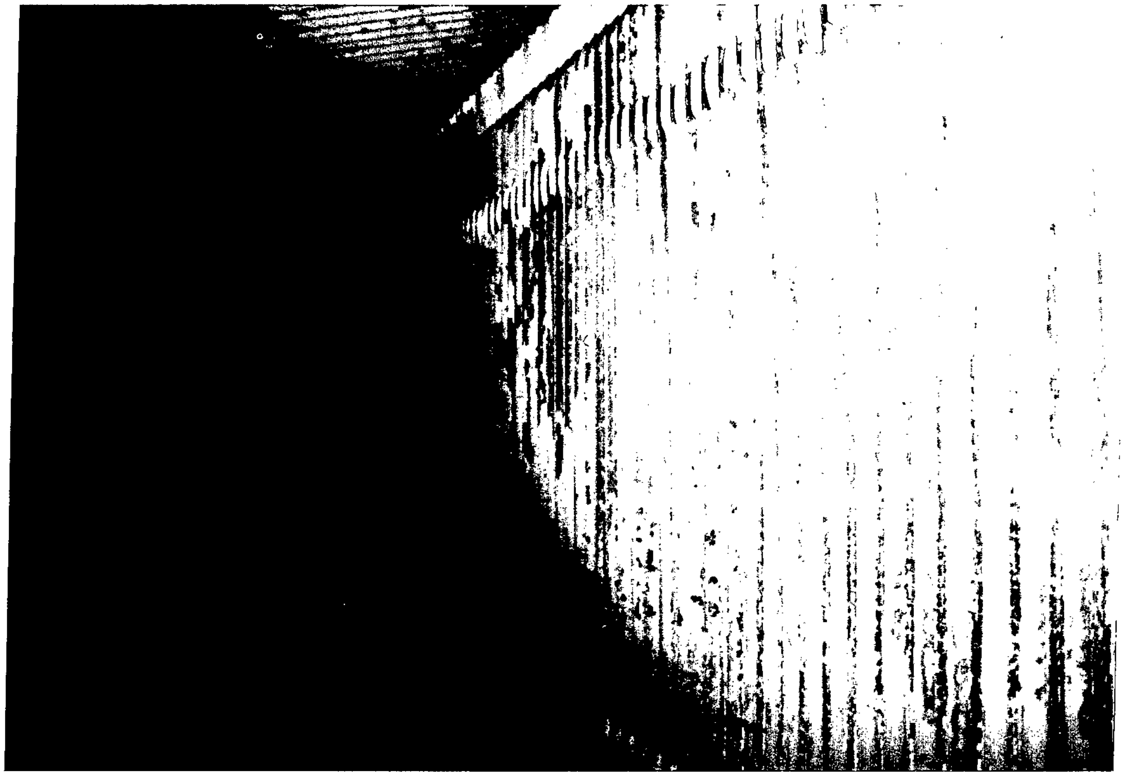

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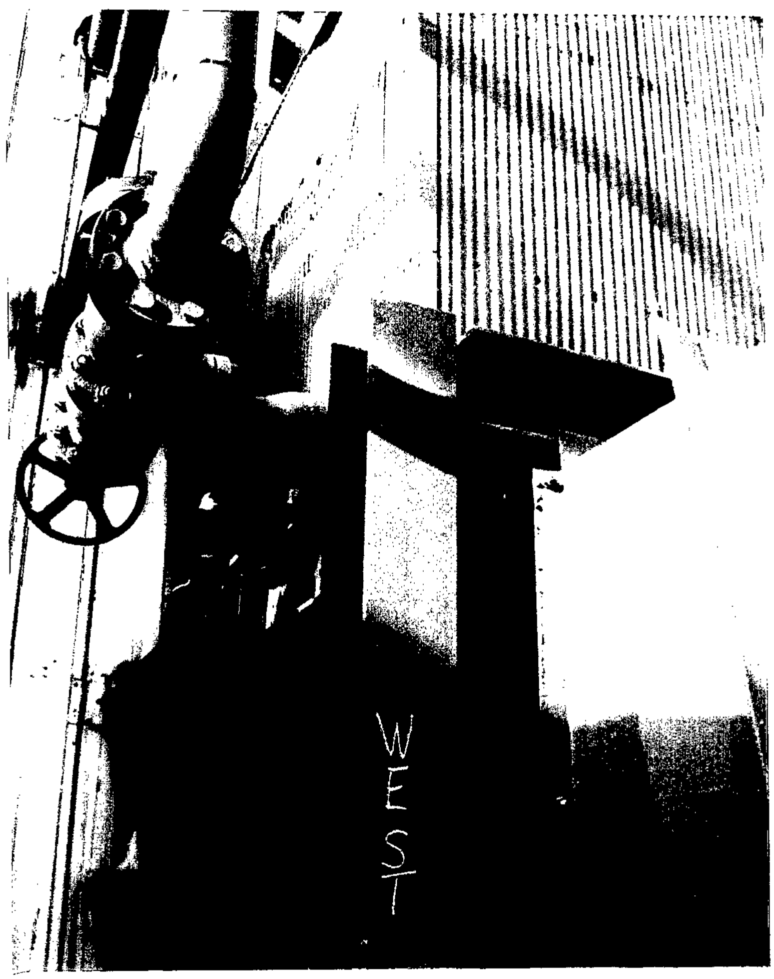


8

APPENDIX G

DEAERATING TANK

INSPECTION

Deaerating Feed Tanks

The two deaerating feed tanks were visually inspected both internally and externally. The name plate data is as follows:

	East DA Tank		West DA Tank
Mfg by:	Dun-Rite Tank Corp.		Dun-Rite Tank Corp
MAWP:	30 psi @ 500F		30 psi @ 500F
Mfg Ser #:	5560-2	S	5560-1
Nat'l Bd #:	1721	Div 1	1720
Year built:	1972	W	1972
Shell t:	1/4" (.250")		1/4" (.250")
Head t:	1/4" (.250")		1/4" (.250")
Head Radius:	66"		66"

Safety valves (both deaerators)

a. Name plate data:

Manufacturer - Lonergan
Size - 3" x 3"
Capacity - 3,785 lbs/hr

b. Condition - Top seal broken
- Valve stuck closed

East Deaerating Feed Tank

Storage Section, internal:

1) Internal pitting, most predominately adjacent to weld seams but scattered throughout vessel.
2) Significant coating of deposits at water line, lower portion of vessel the deposits are moderate.
3) Gasket surface of manway ring slightly corroded, most notable at inner edge.
4) One desiccant container installed.
5) Moderate surface corrosion from water line down

Deaerating Section, internal:

1) Spray valves (5), appear satisfactory, loose rust flakes noted inside spray valves when opened.
2) No corrosion of tray storage area or trays

External.

1) The following components were noted to be cracked, most likely from freezing conditions:
   a. Lower float chamber of water level control
   b. Lower piping of level control
   c. Secondary lower pipe level control
   d. Sight glass lower pipe connection

West Deaerating Feed Tank

Storage Section, internal:

1) Internal pitting, most predominantly adjacent to weld seams but scattered throughout vessel.
2) Gasket surface of manway ring - inner edge corroded.
3) Thick coating of deposits adhered to shell from water line down.
4) Large amount of loose sediment and rust flakes laying in vessel.
5) 1 desiccant container in vessel.
6) Moderate to heavy amount of surface rust, mostly from water line down.

Deaerating Section, internal:

1) 1 of 5 spray valve is stuck closed.
2) Rust flakes inside other 4 spray valves when opened.
3) no corrosion of tray storage area or trays.

External:

1) The following components were noted to be cracked, most likely from freezing conditions:
   a. Overflow float chamber

Recommendations for East and West Deaerators:

1) Remove all internal deposits, recommended method - high pressure water.
2) Perform wet fluorescent magnetic particle examination of all internal weld joints to identify any cracking that may have developed during the years of operation.
3) The depth of pitting in the storage section is a concern - the pitting should be measure and compared to the original thickness to identify the current MAWP.
4) The storage section shell and heads should be measured for thickness to determine the extent of thinning from corrosion to determine the current MAWP.
5) Repair of replace both safety valves

NOTE: These vessels should not be placed into operation until the current conditions as indicated in the Recommendations Section are performed.

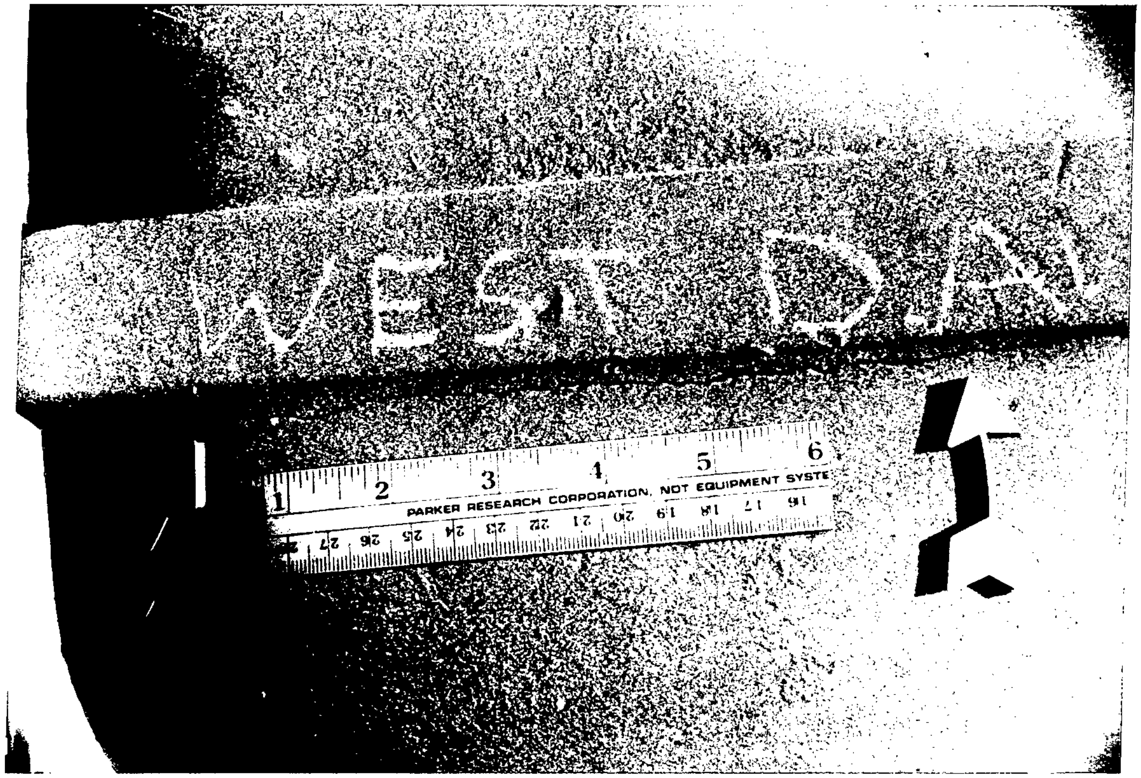
APPENDIX H

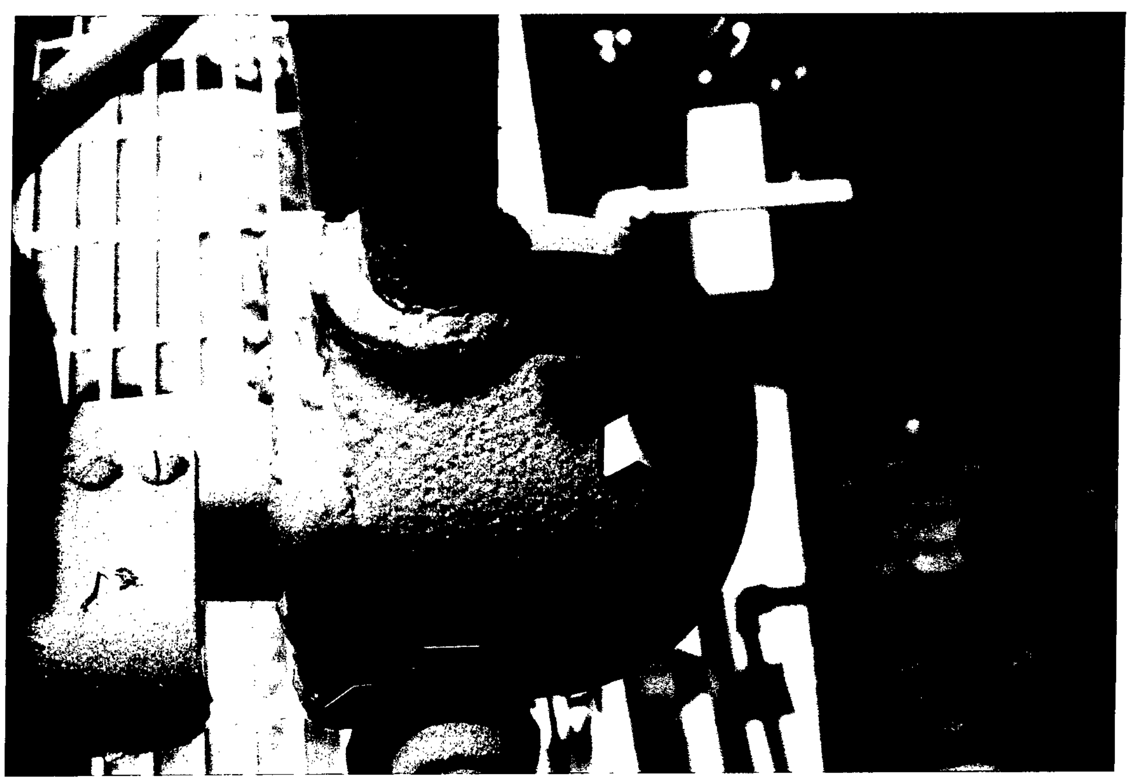
DEAERATING TANK

PICTURES

Deaerating Feed Tank Photograph Log

Photograph #	Description
1	West DA tank. Crack in overflow float chamber
2	East DA tank. Crack in float chamber of liquid level control.
3	East DA tank. Crack and rust on piping
4	Typical of both DA tanks. Notice the pitting adjacent to the weld joint. The depth of the pitting is of concern due to the thickness of the shell (1/4").
5	Typical of both DA tanks. Notice the extent of corrosion on the bottom half of the vessel. Additionally, notice the heavier concentration of corrosion and sediment at the water line.


WEST DAM
1
2
3
4
5
6
PARKER RESEARCH CORPORATION, NOT EQUIPMENT SYSTE
1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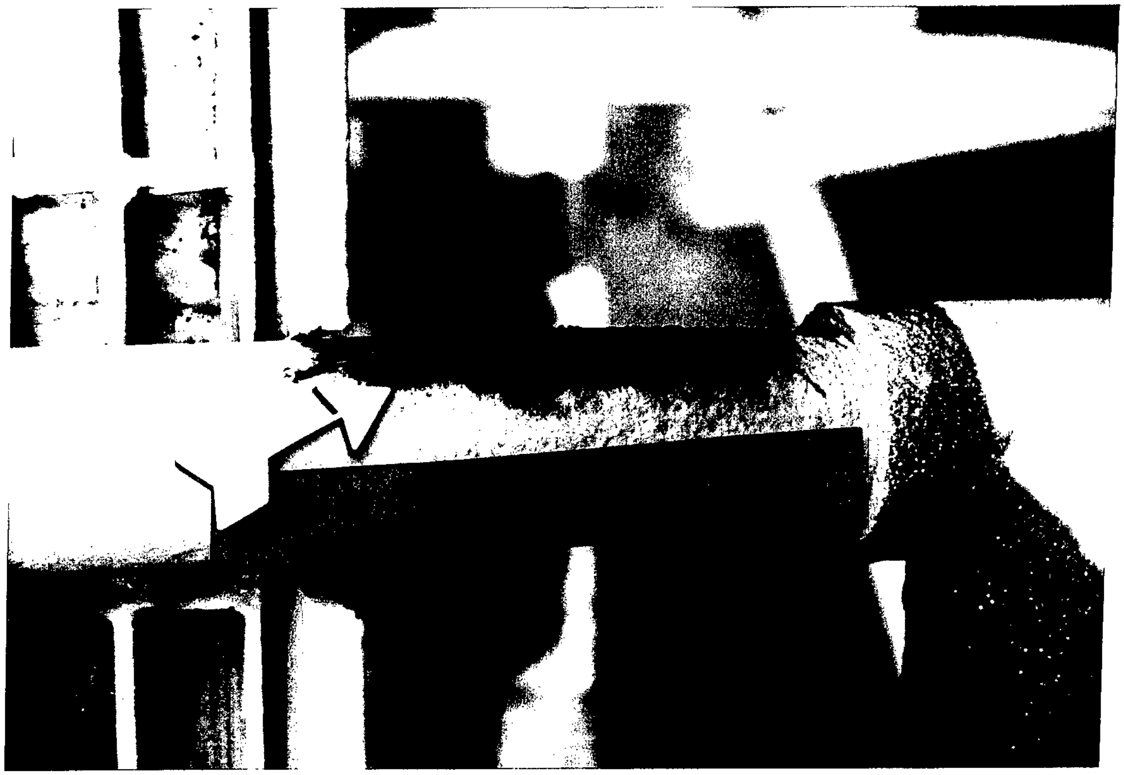

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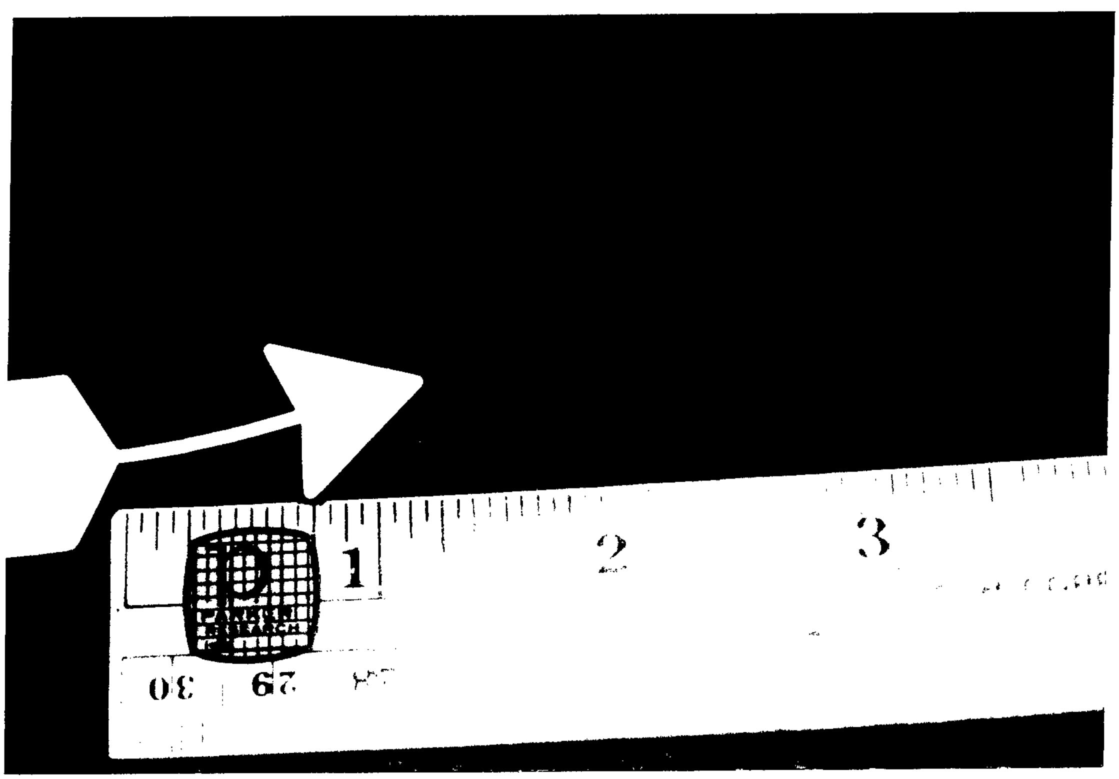

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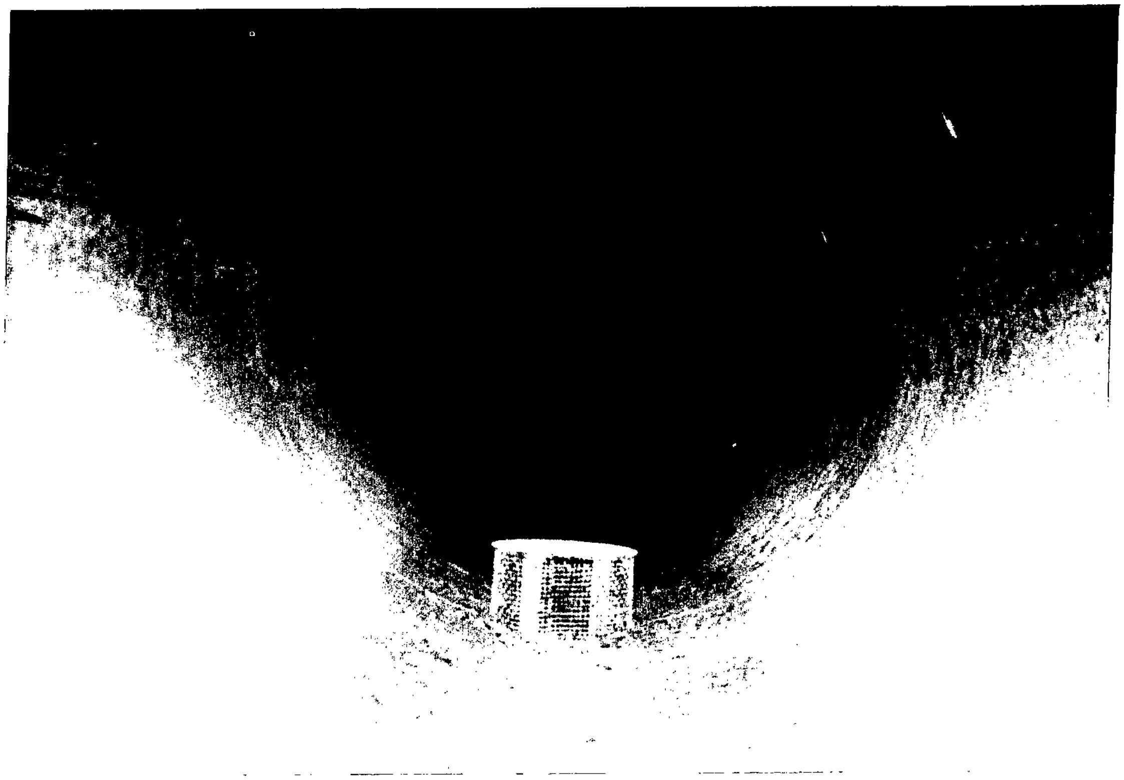

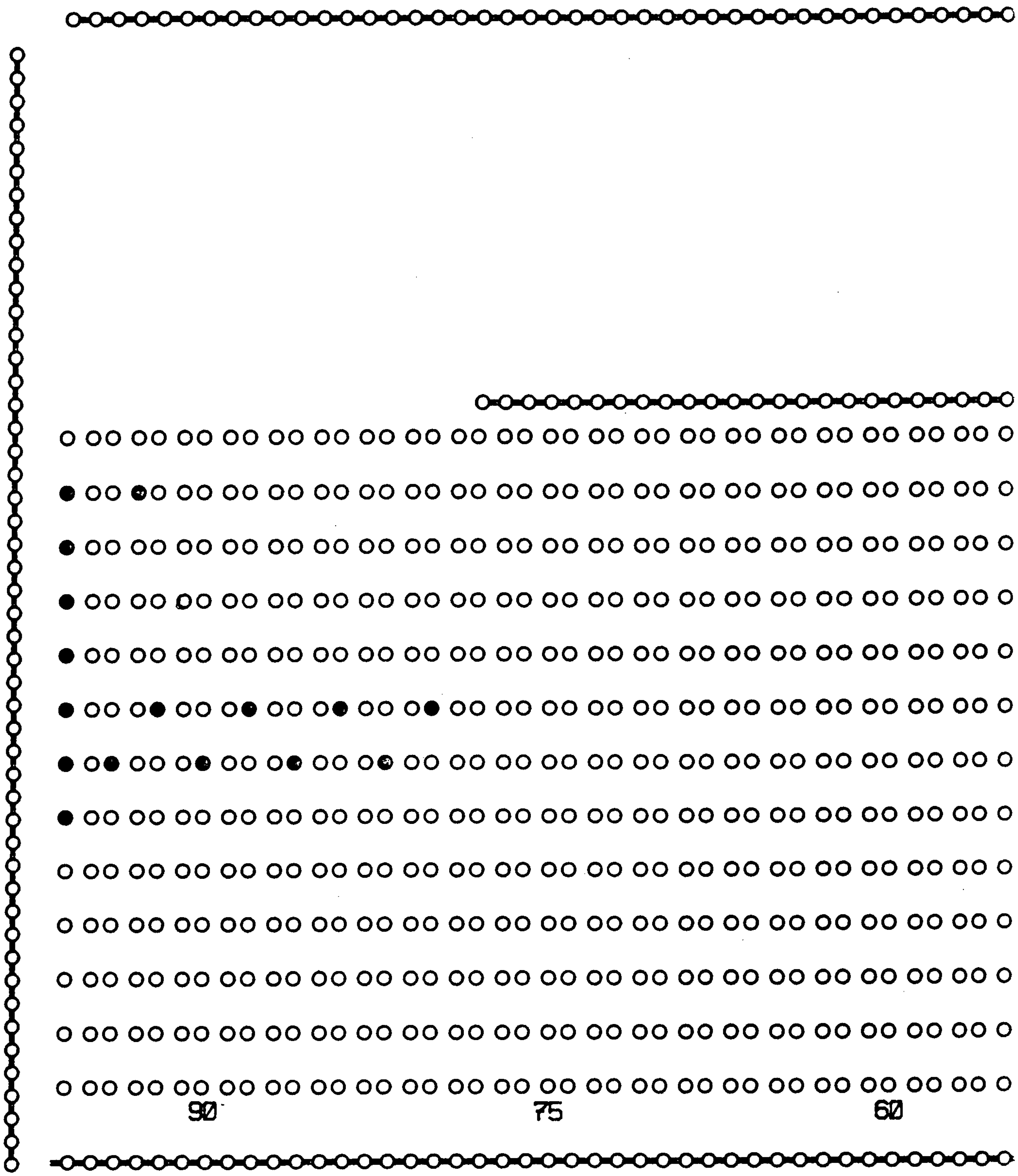

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EAST BOILE

National B

Hartford Stear
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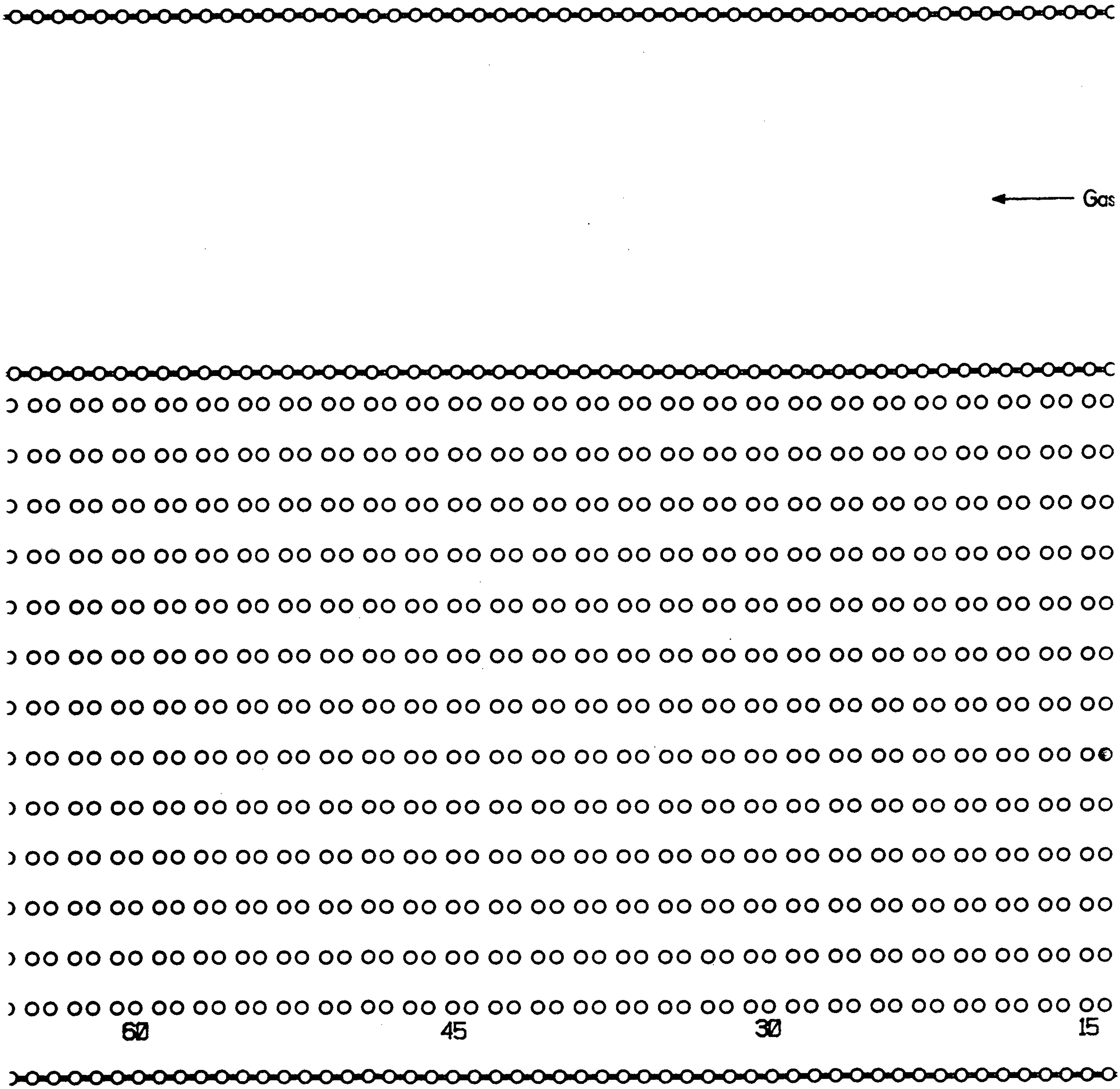
Atlanta, Georgi:

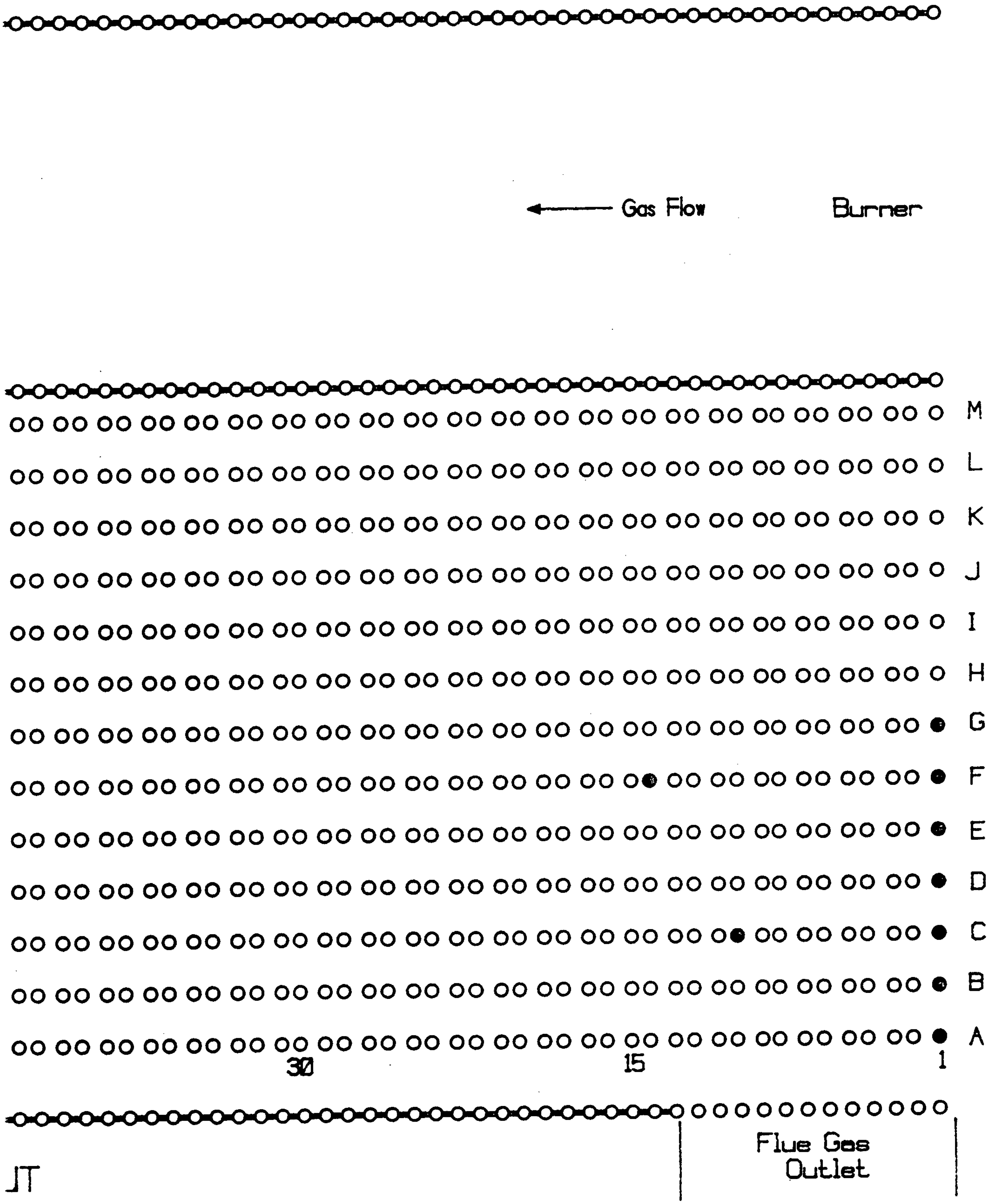


EAST BOILER TUBE LAYOUT

National Board # 23636

2

Hartford Steam Boiler Inspection
and Insurance Company
Atlanta, Georgia



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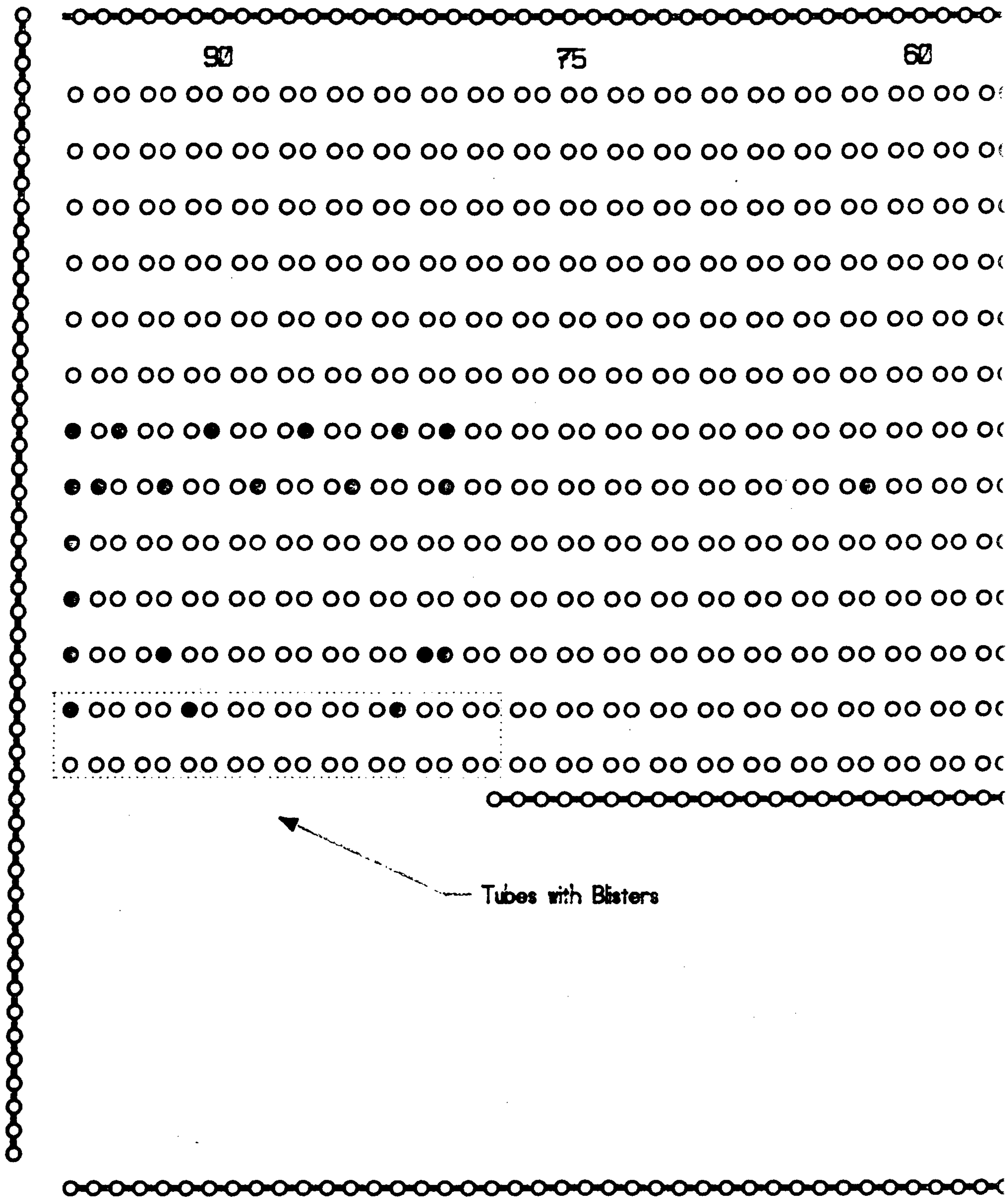
(3)



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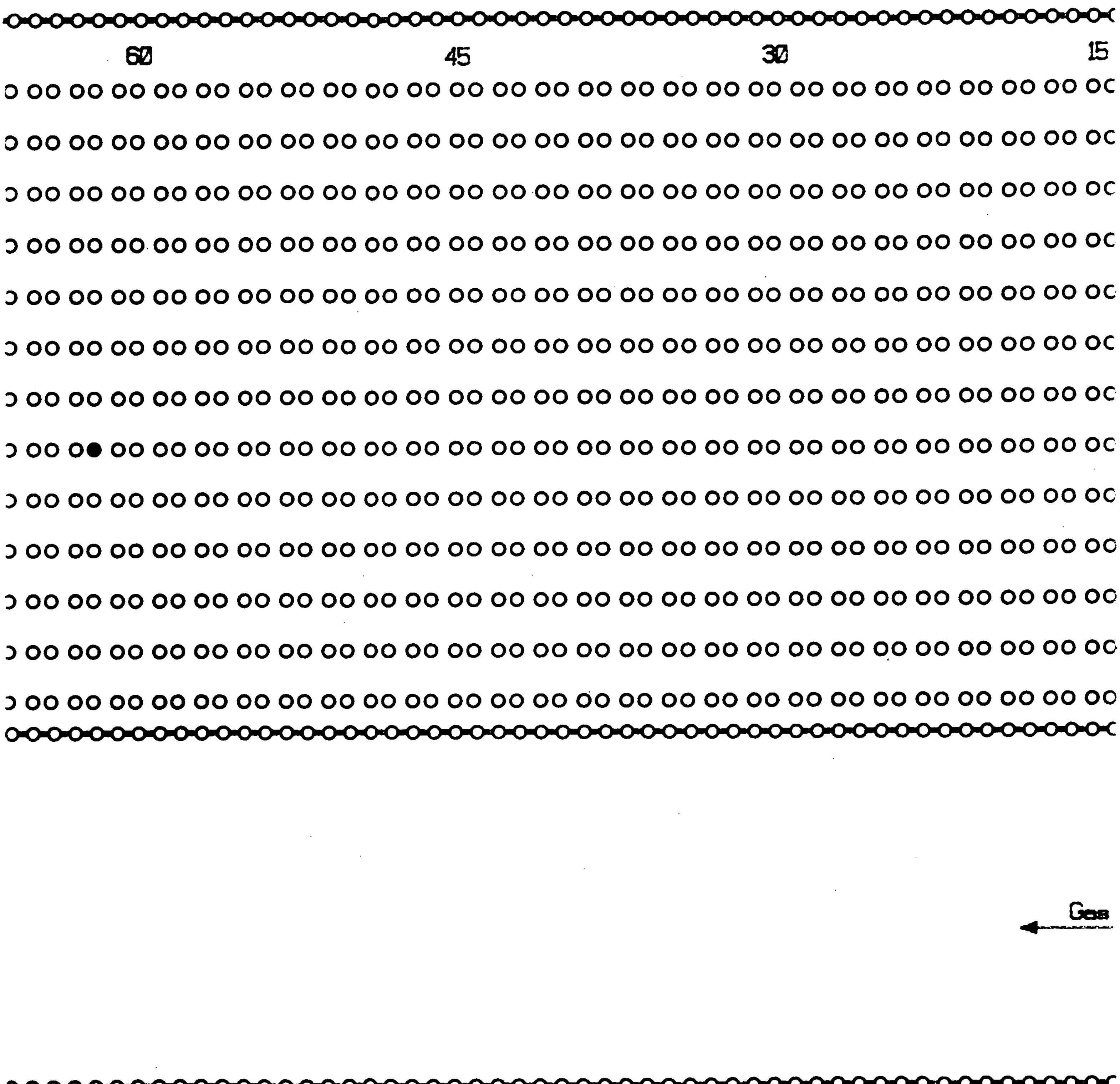
WEST B

Not

1



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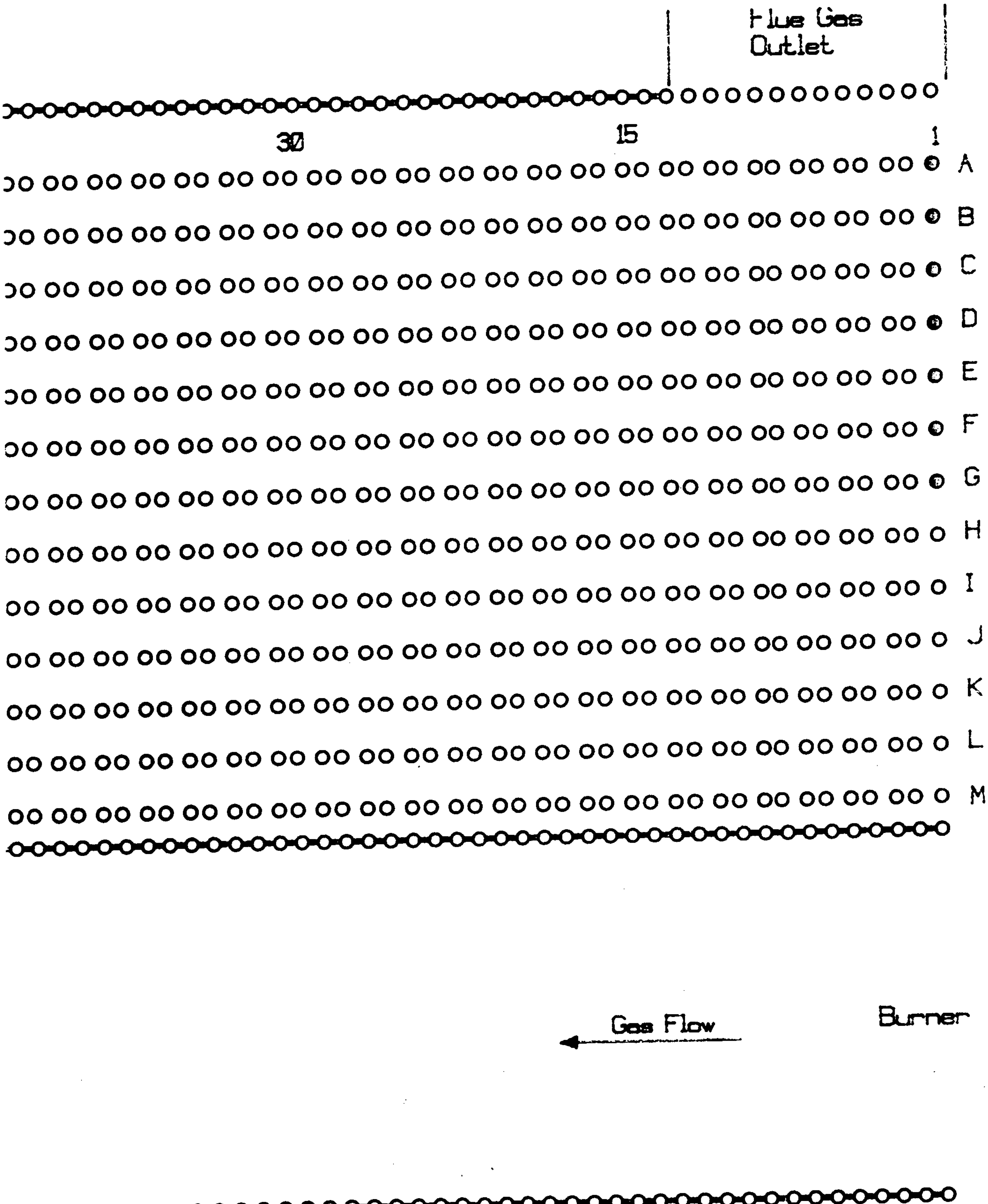
Atlanta, Geor

WEST BOILER TUBE LAYOUT

National Board # 23635

2



Hartford Steam Boiler Inspection
and Insurance Company
Atlanta, Georgia

/OUT

3

1. COMPONENT ARMY	FY 19 96 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 1 NOV. 1995

3. INSTALLATION AND LOCATION	4. PROJECT TITLE
HOLSTON ARMY AMMUNITION PLNT. KINGSPORT, TN.	ECIP NEW 800 bhp BOILER

5. PROGRAM ELEMENT	6. CATEGORY CODE	7. PROJECT NUMBER	8. PROJECT COST ($000)
			$420.0

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
800 bhp FIRETUBE BOILER w/ DEAERATING HEATER/FEEDPUMP PACKAGED UNIT		1		362.5
SIOH				27.5
DESIGN				30.0
TOTAL				420.0

10. DESCRIPTION OF PROPOSED CONSTRUCTION

INSTALL ONE 800 bhp (27,000 LB/HR) NATURAL GAS FIRED 100 PSIG OPERATING PRESSURE STEAM BOILER AND PACKAGED DEAERATING HEATER/FEEDPUMP SET IN BUILDING 7 - ACETIC ANHYDRIDE MANUFACTURING. PROPOSED INSTALLATION TO BE AT GROUND FLOOR LEVEL IN GENERAL PROXIMITY TO EXISTING HEAT RECOVERY BOILER.

DD FORM 1391, 1 DEC 76 PREVIOUS EDITIONS MAY BE USED INTERNALLY UNTIL EXHAUSTED. PAGE NO.

FOR OFFICIAL USE ONLY
(WHEN DATA IS ENTERED)

installation: HOLSTON ARMY AMMUNITION PLANT

project: INSTALL NATURAL GAS FIRED BOILER

project number
temporary: ______ program year FY 96

permanent: ______ category code ______

point of contact:

user
name SCOTT SHELTON date ______

title SIOHS-EN phone 423-247-9111 x 3471

autovon ______

dfae
name ______ date ______

title ______ phone ______

autovon ______

engineer district
name TONY BATTAGLIA date ______

title CESAM-EN phone 205-690-2618

autovon ______

other (A-E)
name ______ date ______

title ______ phone ______

autovon ______

reviewed by:

installation facility engineer
name ______ date ______

title ______ phone ______

autovon ______

approved by:

macom engineer
name ______ date ______

title ______ phone ______

autovon ______

project development brochure, PDB-1

DA FORM 5020-R, Feb 82

facility

HOLSTON
ARMY AMMUNITION
PLANT

project coordinator for using service

SCOTT SHELTON
SIOHS-EN

MAAP - ARMY

functional requirements summary, PDB-1

DA FORM 5020-1-R, Feb 82

OBJECTIVE

THE OBJECTIVE OF THIS PROJECT IS TO IMPROVE THE OPERATING CAPABILITY OF THE EXISTING STEAM PRODUCTION SYSTEM AT LOW PRODUCTION RATES WHILE STILL MAINTAINING FACILITIES CAPABLE OF BEING RETURNED TO SERVICE WITHIN A SHORT TIME FRAME PURSUANT TO SUPPLYING ANY INCREASED PRODUCTION DEMANDS.

BUILDINGS SERVED

BLDG 1 ADMINISTRATION
BLDG. 1A GAURD HOUSE
BLDG. 2 ACID CONCENTRATION BLDG.
BLDG. 4 ELECTRICAL INSTR. SHOP
BLDG. 5 REFRIGERATION PLANT
BLDG. 6 ACETIC ANHYDRIDE REFINING
BLDG. 7 ACETIC ANHYDRIDE MANUFACTURING
BLDG. 9 WATER PLANT
BLDG. 11 PUMP HOUSE
BLDG. 14 CHANGE HOUSE
BLDG. 15 STOREHOUSE
BLDG. 16 FIREHOUSE
BLDG. 18 RED CROSS

functional requirements summary, PDB-1

DA FORM 5020-2-R, Feb 82

BUILDINGS SERVED (CONT.)

BLDG. 20 ACETIC ANHYDRIDE FURNACES

BLDG. 27A OFFICE

BLDG. 27B OFFICE

BLDG. 31 CHANGEHOUSE

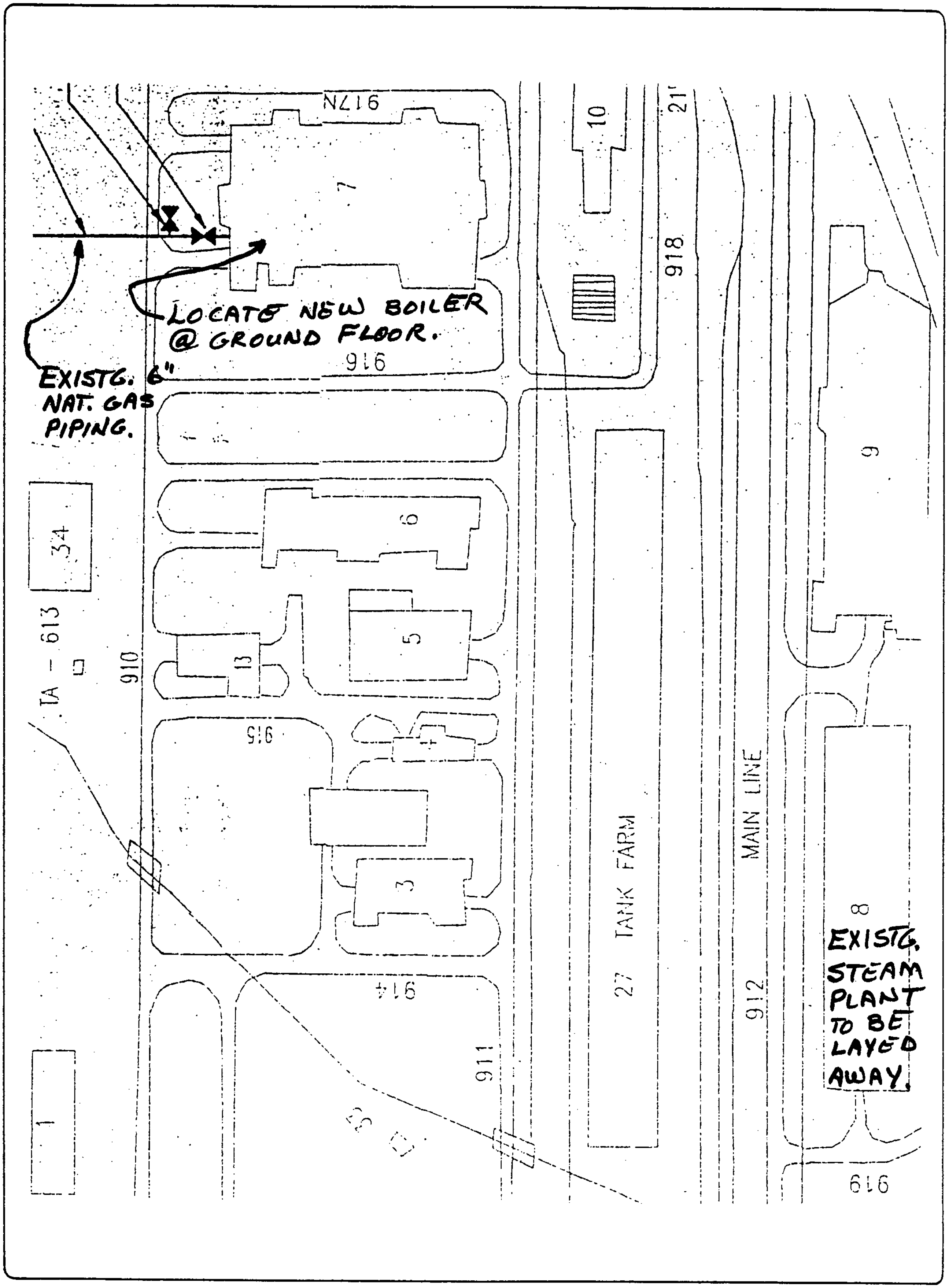
TANK HEATING AND PIPELINE TRACING

SOLUTION

PROVIDE 800 bhp NATURAL GAS FIRED FIRETUBE STEAM BOILER TO DELIVER SATURATED STEAM AT 100 PSIG TO THE EXISTING STEAM DISTRIBUTION PIPING SYSTEM. NEW BOILER TO BE INSTALLED IN SPACE AVAILABLE IN EXISTING BUILDING 7. EXISTING COAL FIRED STEAM BOILERS AND BOILER AUXILIARIES WILL BE "LAYED AWAY" FOR FUTURE REACTIVATION.

functional requirements summary, PDB-1

DA FORM 5020-2-R, Feb 82



facilities requirements sketch, PDB- ½

A. SPECIAL CONSIDERATIONS

	ITEM	Required or Not Required	To Be Determined *	Comment Attached	Document Attached
A-1	Cost estimates for each primary and supporting facility	R	D		
A-2	Telecommunications system coordination with USACC and authorization for exceptions	NR			
A-3	Coordination with state and local governmental requirements (blind vendors, medical facilities, construction and operating permits, clearinghouse ccoordination, etc.)	NR			
A-4	Assignment of airspace	NR			
A-5	Economic analysis of alternatives	R	D		
A-6	Approval for new starts	NR			
A-7	International balance of payments (IBOP) coordination with U.S. European command and NATO—overseas cost estimates and comparables (include rate of exchange used in estimates)	NR			
A-8	Impact on historic places—on site survey by authorized archeologist and coordination with state historic preservation officer and advisory council on historic preservation	NR			
A-9	Exceptions to established criteria	NR			
A-10	Coordination with various staff agencies (Provost Marshall-physical security, etc.)	NR			
A-11	Identification of related or support projects (so projects can be coordinated)	NR			
A-12	Required completion date	R	A		
	Other Special Considerations (List and number items)				

REQUIRED OR NOT REQUIRED – Not relevant or no information to communicate. Enter "R" if item is relevant and is required for this project. Enter "NR" if item is irrelevant and is not required for this project.

TO BE DETERMINED – Information needed but not currently available. Enter code for information source.

COMMENT ATTACHED – Significant information summarized or explained and attached.

DOCUMENT ATTACHED – Significant information is in an existing document which is attached.

*BY WHOM (Check and insert appropriate letter)

A – DFAE
B – Using Service
C – Construction Service
D – Designer
E – Other (Check Comments Attached and explain)

documentation checklist

DA FORM 5023-A-R, Feb 82

B. SITE DEVELOPMENT

	ITEM	Required or Not Required	To Be Determined *	Comment Attached	Document Attached
B-1	Consultation with the District Office to determine and evaluate flood plain hazards	NR			
B-2	Preparation, submission, and/or approval of new				
(A)	General Site Plan	NR			
(B)	Annotated General Site Plan	NR			
(C)	Sketch Site Plan	NR			
(D)	Facilities Requirements Sketch	NR			
B-3	Preparation of				
(A)	Site Survey	NR			
(B)	Subsoil information	NR			
B-4	Approval by Department of Defense Explosive Safety Board (DDESB) for Safety Site Plan	NR			
	Other Site Development Considerations (List and number items)				

REQUIRED OR NOT REQUIRED – Not relevant or no information to communicate. Enter "R" if item is relevant and is required for this project. Enter "NR" if item is irrelevant and is not required for this project.

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documentation checklist

DA FORM 5023-B-R, Feb 82

C. ARCHITECTURAL & STRUCTURAL

	ITEM	Required or Not Required	* To Be Determined	Comment Attached	Document Attached
C-1	Reconciliation with troop housing programs and requirements	NR			
C-2	Evaluation of existing facilities (including degree of utilization)	R	D		
C-3	Approval for removal and relocation of existing useable facilities	NR			
C-4	Evaluation of off-post community facilities	NR			
C-5	Storage and maintenance facilities (including nuclear weapons)	NR			
C-6	Coordination hospitals, medical and dental facilities with Surgeon General	NR			
C-7	Coordination of aviation facilities with FAA	NR			
C-8	Coordination air traffic control and navigational aids with USACC	NR			
C-9	Tabulation of types and numbers of aircraft	NR			
C-10	Evaluation of laboratory, research and development, and technical maintenance facilities	NR			
C-11	Coordination chapels with Chief of Chaplains	NR			
C-12	Review food service facilities by USATSA	NR			
C-13	Automated data processing system or equipment approvals—cost analysis when ADP and/or communication centers not co-located with related facilities	NR			
C-14	Coordination postal facilities with U.S. Postal Service Regional Director	NR			
C-15	Laundry and dry cleaning facilities coordination with ASD(I&L)	NR			
C-16	Tenant facilities coordination with installation where sited		B		
C-17	Facilities for or exposed to explosions, toxic chemicals, or ammunition—review by DDESB (See also Item B-4)		A/B		
C-18	Analysis of deficiencies	NR			
C-19	Consideration of alternatives	R	A/B		
C-20	Determination whether occupants will include physically handicapped or disabled persons	NR			
C-21	As-build drawings for alterations or additions	R	A/B		
C-22	Availability of Standard Design or site adaptable designs	NR			
	Other Architectural & Structural (List and number items)				

REQUIRED OR NOT REQUIRED – Not relevant or no information to communicate. Enter "R" if item is relevant and is required for this project. Enter "NR" if item is irrelevant and is not required for this project.

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B – Using Service
C – Construction Service
D – Designer
E – Other (Check Comments Attached and explain)

documentation checklist

DA FORM 5023-C-R, Feb 82

D. MECHANICAL, ELECTRICAL, & UTILITY SYSTEMS

	ITEM	Required or Not Required	* To Be Determined	Comment Attached	Document Attached
D-1	Fuel considerations and cost comparison analysis	R	D		
D-2	Energy requirements appraisal (ERA)	R			
D-3	Conformance with DOD Energy Reduction requirements	R	D		
D-4	Evaluation of existing and/or proposed utility systems	R	D		
	Other Mechanical and Utility Systems (List and number items)				

REQUIRED OR NOT REQUIRED – Not relevant or no information to communicate. Enter "R" if item is relevant and is required for this project. Enter "NR" if item is irrelevant and is not required for this project.

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A – DFAE
B – Using Service
C – Construction Service
D – Designer
E – Other (Check Comments Attached and explain)

documentation checklist

DA FORM 5023-D-R, Feb 82

E. ENVIRONMENTAL CONSIDERATIONS

	ITEM	Required or Not Required	To Be Determined *	Comment Attached	Document Attached
E-1	Environmental impact assessment	NR			
E-2	EIA conclusions require Environmental Impact Statement	NR			
E-3	Determination of health, environmental or related hazards. Assistance to determine existence of any health, environmental or related hazard may be requested from Aberdeen Proving Ground, MD 21010, the Office of the Surgeon General, Attn: DASG-HCH (Army Environmental Hygiene Agency)	NR			
E-4	Air/water pollution permit, coordination with agencies and compliance with standards at Federal, state and local level	R	B		
E-5	Corrective measures associated with Environmental Impact Statements or assessment—list separately and evaluate.	NR			
	Other environmental considerations (list and number items)				

REQUIRED OR NOT REQUIRED – Not relevant or no information to communicate. Enter "R" if item is relevant and is required for this project. Enter "NR" if item is irrelevant and is not required for this project.

TO BE DETERMINED – Information needed but not currently available. Enter code for information source.

COMMENT ATTACHED – Significant information summarized or explained and attached.

DOCUMENT ATTACHED – Significant information is in an existing document which is attached.

*BY WHOM (Check and insert appropriate letter)

A – DFAE

B – Using Service

C – Construction Service

D – Designer

E – Other (Check Comments Attached and explain)

documentation checklist

DA FORM 5023-E-R, Feb 82

A. SPECIAL CONSIDERATIONS

	ITEM	Required or Not Required	To Be Determined *	Comment Attached	Document Attached
A-1	Factors of risk, restriction or unusual circumstance expected to increase costs beyond applicable area averages	NR			
A-2	Construction phasing requirements	NR			
A-3	Functional support equipment (mechanical, electrical, structural, and security) to be built in	NR			
A-4	Equipment in place and justification	NR			
A-5	Other equipment and furniture (O&MA, OPA) and costs	NR			
A-6	Special studies and tests (hazards analyses, compatibility testing, new technology testing, etc.)	NR			
A-7	Type of construction (permanent, temporary, semi-permanent)	R	A		
A-8	Government furnished equipment (quantities, procurement time, availability and special handling and storage requirements). Funds used for procurement.	NR			
	Other special considerations (list and number items)				

REQUIRED OR NOT REQUIRED – Not relevant or no information to communicate. Enter "R" if item is relevant and is required for this project. Enter "NR" if item is irrelevant and is not required for this project.

TO BE DETERMINED – Information needed but not currently available. Enter code for information source.

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*BY WHOM (Check and insert appropriate letter)

A – DFAE
B – Using Service
C – Construction Service
D – Designer
E – Other (Check Comments Attached and explain)

technical data checklist

DA FORM 5024-A-R, Feb 82

B. SITE DEVELOPMENT

	ITEM	Required or Not Required	To Be Determined*	Comment Attached	Document Attached
B-1	Construction restrictions or guidelines pertaining to				
(A)	site access and preferred construction routes	NR			
(B)	Airfield clearance, explosive storage, working hours, safety, etc.	NR			
(C)	Facilities and/or functions or adjoining areas (structures, materials, impact)	NR			
B-2	Real estate actions (acquisition, disposal, lease, right-of-way)	NR			
B-3	Demolition/relocation required (data)				
(A)	Special considerations due to explosives/radioactivity/ chemical contamination/asbestos emissions/toxic gases	R	B		
(B)	Restrictions on disposal of demolished/relocated material including hazardous waste	R	B		
B-4	Pavement types and requirements (including traffic surveys and MTMC coordination)	NR			
B-5	Landscape considerations				
(A)	Protection of existing vegetation	NR			
(B)	Stockpile topsoil	NR			
	Other Site Development (List and number items)				

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E – Other (Check Comments Attached and explain)

technical data checklist

DA FORM 5024-B-R, Feb 82

C. ARCHITECTURAL & STRUCTURAL

	ITEM	Required or Not Required	To Be Determined *	Comment Attached	Document Attached
C-1	Vibration-producing equipment requiring isolation	NR			
C-2	Seismic zone and other design load criteria (typhoon, hurricane, earthquake loads, high or low loss potential)	NR			
C-3	Protective shelter evaluation and resistant design criteria (conventional/nuclear blast and radiation, chemical/biological)	NR			
C-4	Unusual foundation requirements (pier, pile, caisson, deep foundations, mat, special treatment, permafrost areas, soil bearing)	NR			
C-5	Designation and strength of units to be accommodated	NR			
C-6	Requirements and data for special design projects	NR			
C-7	Unusual floor and roof loads (safes, equipment)	NR			
C-8	Security features (arms rooms, vaults, interior secure areas)	NR			
	Other Architectural & Structural (List and number items)				

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technical data checklist

DA FORM 5024-C-R, Feb 82

D. MECHANICAL, ELECTRICAL, & UTILITY SYSTEMS

	ITEM	Required or Not Required	To Be Determined *	Comment Attached	Document Attached
D-1	Special mechanical requirements or considerations (elevator, crane, hoist, etc.)	NR			
D-2	Special peak usage periods and peak leveling techniques	NR			
D-3	Maintenance considerations (accessibility of equipment, compatibility with existing equipment)	R	D		
D-4	Plumbing—availability, general system type and characteristics (proposed and/or existing, incl. compressed air and gas)	NR			
D-5	Heating—availability, general system type and characteristics (proposed and/or existing)	NR			
D-6	Ventilating, air condition/refrigeration—availability, general system type and characteristics (proposed and/or existing)	R	D		
D-7	Electrical—availability, general system type and characteristics incl. airfield lighting, communication, etc. (proposed and/or existing)	R	D		
D-8	Water supply/waste treatment—availability, general system type and characteristics (proposed and/or existing)	R	D		
D-9	Energy requirements/fuel conversion (sources, availability, loads, types of fuel, etc.)	R	D		
D-10	Solar energy evaluation	NR			
	Other Mechanical & Utility Systems (List and number items)				

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technical data checklist

DA FORM 5024-D-R, Feb 82

E. ENVIRONMENTAL CONSIDERATIONS

	ITEM	Required or Not Required	To Be Determined *	Comment Attached	Document Attached
E-1	Waste water treatment, air quality, and solid waste disposal criteria	R	B		
	Other Environmental Considerations (List and number items)				

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technical data checklist

DA FORM 5024-E-R, Feb 82

F. FIRE PROTECTION

	ITEM	Required or Not Required	* To Be Determined	Comment Attached	Document Attached
F-1	Special fire protection systems or features (detection and suppression equipment, hazards, etc.)	NR			
	Other Fire Protection Considerations (List and number items)				

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technical data checklist

DA FORM 5024-F-R, Feb 82

installation: HOLSTON ARMY AMMUNITION PLANT

project: INSTALL NATURAL GAS FIRED BOILER

project number
temporary: ________ program year FY 96

permanent: ________ category code ________

point of contact:

user
name SCOTT SHELTON date ________

title SIOHS-EN phone 423-247-9111 X 3471

autovon ________

dfae
name ________ date ________

title ________ phone ________

autovon ________

engineer district
name TONY BATTAGLIA date ________

title CESAM-EN phone 205-690-2618

autovon ________

other (A-E)
name ________ date ________

title ________ phone ________

autovon ________

reviewed by:

installation facility engineer
name ________ date ________

title ________ phone ________

autovon ________

approved by:

macom engineer
name ________ date ________

title ________ phone ________

autovon ________

project development brochure, PDB-2

DA FORM 5021-R, Feb 82

facility

HOLSTON
ARMY AMMUNITION
PLANT

project coordinator for using service

SCOTT SHELTON
SIOHS-EN

MAAP- ARMY

detailed functional requirements, PDB-2

DA FORM 5021-1-R, Feb 82

OBJECTIVE

THE OBJECTIVE OF THIS PROJECT IS TO IMPROVE THE OPERATING CAPABILITY OF THE EXISTING STEAM PRODUCTION SYSTEM AT LOW PRODUCTION RATES WHILE STILL MAINTAINING FACILITIES CAPABLE OF BEING RETURNED TO SERVICE WITHIN A SHORT TIME FRAME PURSUANT TO SUPPLYING ANY INCREASED PRODUCTION DEMAND.

SOLUTION

PROVIDE 800 bhp NATURAL GAS FIRED STEAM BOILER TO DELIVER SATURATED STEAM AT 100 PSIG TO THE EXISTING STEAM DISTRIBUTION PIPING SYSTEM. NEW BOILER TO BE INSTALLED IN SPACE AVAILABLE IN EXISTING BUILDING 7. EXISTING COAL FIRED STEAM BOILERS AND BOILER AUXILIARIES WILL BE "LAYED AWAY" FOR FUTURE REACTIVATION.

detailed functional requirements, PDB- 2

DA FORM 5021-2-R, Feb 82

background information

PRODUCTION OF RESEARCH DEVELOPMENT EXPLOSIVE (RDX), FOLLOWING THE MINIMAL CURRENT PRODUCT DEMAND, IS AT A LEVEL LOW ENOUGH TO DICTATE WASTEFUL OPERATING PRACTICES TO AVOID VIOLATIONS OF AIR POLLUTION REGULATIONS AT THE EXISTING COAL FIRED STEAM BOILERS. IT HAS BEEN NECESSARY TO RELEASE STEAM TO ATMOS-PERE WHILE OPERATING ONE OF THE EXISTING SEVEN BOILERS AT ITS LOWEST SAFE OPERATING COMBUSTION RATE. THIS PROJECT WILL ELIMINATE THE NEED FOR EMPLOYING THIS WASTEFUL PRACTICE, AND WILL PROVIDE A PROPERLY SIZED BOILER, THUS PERMITTING OPERATION AT LOADS CONDUCIVE TO MAXIMIZING EFFICIENCIES.

detailed functional requirements, PDB-2

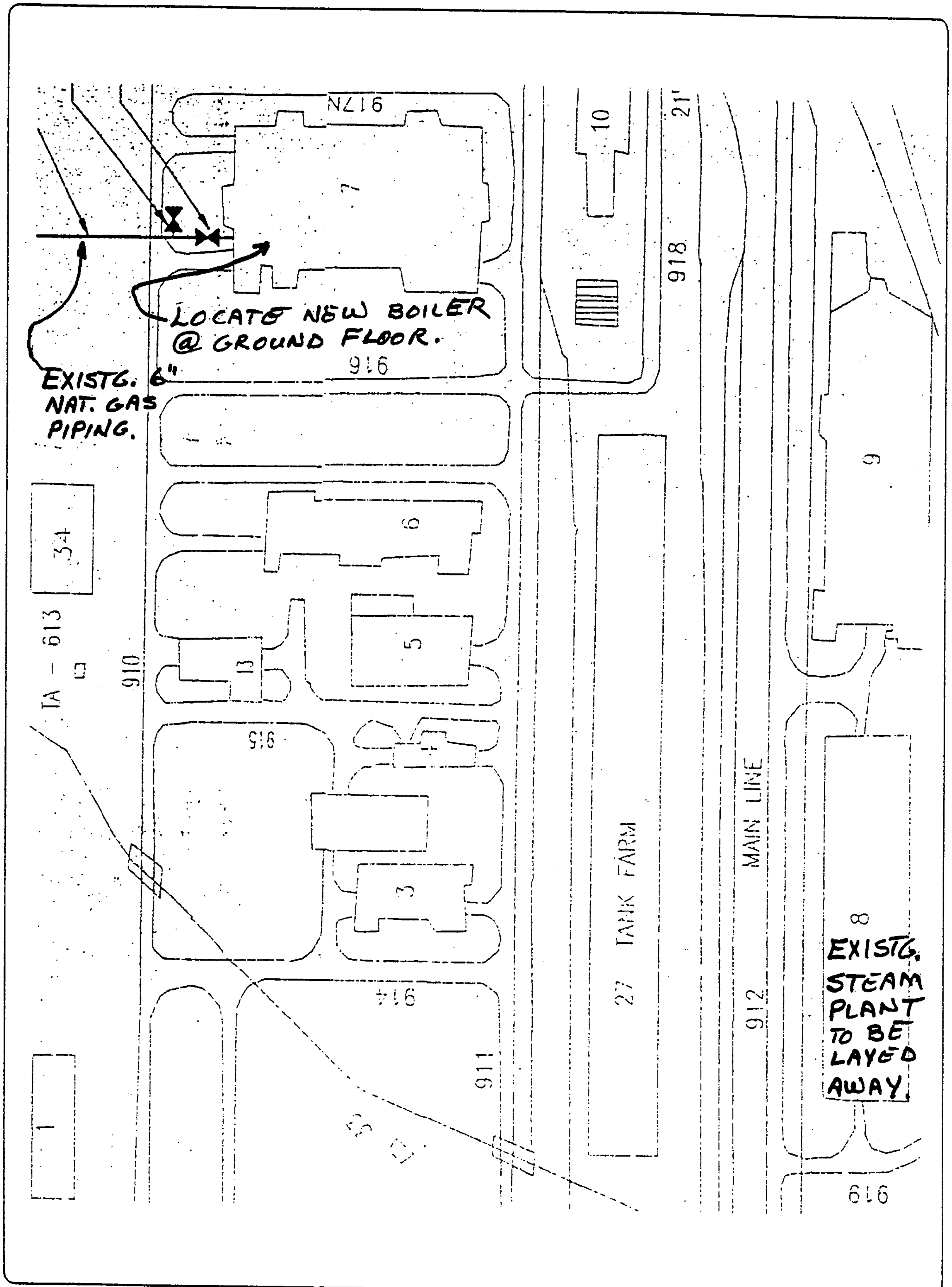
summary data

THREE OTHER METHODS FOR RESOLVING THE STEAM PLANT OPERATING DILEMMA WERE CONSIDERED, BUT EACH OF THEM WAS FOUND TO BE EITHER ECONOMICALLY OR OPERATIONALLY UNSOUND.

THE PROBABLE $362500 CONSTRUCTION COST AND THE ONE-TIME $250,000 COST TO LAYUP EXISTING BLDG. 8 STEAM PLANT WILL SAVE 277,200 MILLION BTU'S ANNUALLY AT CURRENT RDX PRODUCTION RATE, AND WILL REDUCE MAINTENANCE AND OVERHEAD COSTS SIGNIFICANTLY. AN OPTIMISTIC EVALUATION OF MAINTENANCE AND OVERHEAD SAVINGS WILL RESULT IN SAVINGS TO INVESTMENT RATIO OF 10.70. A MORE CONSERVATIVE VALUE STILL PRODUCES AN SIR OF 4.78, WHILE A PESSIMISTIC APPROACH STILL WILL PRODUCE ECIP QUALIFYING RESULTS.

detailed functional requirements, PDB-2

DA FORM 5021-4-R, Feb 82



facilities requirements sketch, PDB- ½

DA FORM 5022-R, Feb 82

A. SPECIAL CONSIDERATIONS

	ITEM	Required or Not Required	To Be Determined *	Comment Attached	Document Attached
A-1	Cost estimates for each primary and supporting facility	R	D		
A-2	Telecommunications system coordination with USACC and authorization for exceptions	NR			
A-3	Coordination with state and local governmental requirements (blind vendors, medical facilities, construction and operating permits, clearinghouse ccoordination, etc.)	NR			
A-4	Assignment of airspace	NR			
A-5	Economic analysis of alternatives	R	D		
A-6	Approval for new starts	NR			
A-7	International balance of payments (IBOP) coordination with U.S. European command and NATO—overseas cost estimates and comparables (include rate of exchange used in estimates)	NR			
A-8	Impact on historic places—on site survey by authorized archeologist and coordination with state historic preservation officer and advisory council on historic preservation	NR			
A-9	Exceptions to established criteria	NR			
A-10	Coordination with various staff agencies (Provost Marshall-physical security, etc.)	NR			
A-11	Identification of related or support projects (so projects can be coordinated)	NR			
A-12	Required completion date	R	A		
	Other Special Considerations (List and number items)				

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documentation checklist

DA FORM 5023-A-R, Feb 82

B. SITE DEVELOPMENT

	ITEM	Required or Not Required	To Be Determined *	Comment Attached	Document Attached
B-1	Consultation with the District Office to determine and evaluate flood plain hazards	NR			
B-2	Preparation, submission, and/or approval of new				
(A)	General Site Plan	NR			
(B)	Annotated General Site Plan	NR			
(C)	Sketch Site Plan	NR			
(D)	Facilities Requirements Sketch	NR			
B-3	Preparation of				
(A)	Site Survey	NR			
(B)	Subsoil information	NR			
B-4	Approval by Department of Defense Explosive Safety Board (DDESB) for Safety Site Plan	NR			
	Other Site Development Considerations (List and number items)				

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documentation checklist

DA FORM 5023-B-R, Feb 82

C. ARCHITECTURAL & STRUCTURAL

	ITEM	Required or Not Required	To Be Determined *	Comment Attached	Document Attached
C-1	Reconciliation with troop housing programs and requirements	NR			
C-2	Evaluation of existing facilities (including degree of utilization)	R	D		
C-3	Approval for removal and relocation of existing useable facilities	NR			
C-4	Evaluation of off-post community facilities	NR			
C-5	Storage and maintenance facilities (including nuclear weapons)	NR			
C-6	Coordination hospitals, medical and dental facilities with Surgeon General	NR			
C-7	Coordination of aviation facilities with FAA	NR			
C-8	Coordination air traffic control and navigational aids with USACC	NR			
C-9	Tabulation of types and numbers of aircraft	NR			
C-10	Evaluation of laboratory, research and development, and technical maintenance facilities	NR			
C-11	Coordination chapels with Chief of Chaplains	NR			
C-12	Review food service facilities by USATSA	NR			
C-13	Automated data processing system or equipment approvals—cost analysis when ADP and/or communication centers not co-located with related facilities	NR			
C-14	Coordination postal facilities with U.S. Postal Service Regional Director	NR			
C-15	Laundry and dry cleaning facilities coordination with ASD(I&L)	NR			
C-16	Tenant facilities coordination with installation where sited		B		
C-17	Facilities for or exposed to explosions, toxic chemicals, or ammunition—review by DDESB (See also Item B-4)		A/B		
C-18	Analysis of deficiencies	NR			
C-19	Consideration of alternatives	R	A/B		
C-20	Determination whether occupants will include physically handicapped or disabled persons	NR			
C-21	As-build drawings for alterations or additions	R	A/B		
C-22	Availability of Standard Design or site adaptable designs	NR			
	Other Architectural & Structural (List and number items)				

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documentation checklist

DA FORM 5023-C-R, Feb 82

D. MECHANICAL, ELECTRICAL, & UTILITY SYSTEMS

	ITEM	Required or Not Required	* To Be Determined	Comment Attached	Document Attached
D-1	Fuel considerations and cost comparison analysis	R	D		
D-2	Energy requirements appraisal (ERA)	R			
D-3	Conformance with DOD Energy Reduction requirements	R	D		
D-4	Evaluation of existing and/or proposed utility systems	R	D		
	Other Mechanical and Utility Systems (List and number items)				

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documentation checklist

DA FORM 5023-D-R, Feb 82

E. ENVIRONMENTAL CONSIDERATIONS

	ITEM	Required or Not Required	To Be Determined *	Comment Attached	Document Attached
E-1	Environmental impact assessment	NR			
E-2	EIA conclusions require Environmental Impact Statement	NR			
E-3	Determination of health, environmental or related hazards. Assistance to determine existence of any health, environmental or related hazard may be requested from Aberdeen Proving Ground, MD 21010, the Office of the Surgeon General, Attn: DASG-HCH (Army Environmental Hygiene Agency)	NR			
E-4	Air/water pollution permit, coordination with agencies and compliance with standards at Federal, state and local level	R	B		
E-5	Corrective measures associated with Environmental Impact Statements or assessment—list separately and evaluate.	NR			
	Other environmental considerations (list and number items)				

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documentation checklist

DA FORM 5023-E-R, Feb 82

See Tech. Data Checklist Item	B. SITE DEVELOPMENT ITEM		Required or Not Required	To Be Determined*	Comment Attached	Document Attached
B-1	B-1	Required site plans (incl. design and construction factors)				
	(A)	Site access and preferred construction routes	R	B/C		
	(B)	Site restrictions (airfield clearance, explosive storage, etc.)	NR			
	(C)	Existing facilities/functions on adjoining areas (structures, materials, impact)	R	B/C		
	(D)	Disposal areas (trash, excavated material, constraints)	R	B/C		
	(E)	Borrow and spoil areas	NR			
	(F)	Grades or contours existing	NR			
	(G)	Existing trees, turf, ground cover, landscape development, erosion control	NR			
	(H)	Bridges and fences (applicable design criteria)	NR			
	(I)	Railroads (routing, sidings, docks, yards, grounding)	NR			
	(J)	Fire station and security police location	NR			
	(K)	Site utilities—capacity and quantity available to project (sanitary and storm sewers, drainage ditches, water and gas service, communication lines, hydrants and sprinklers, etc.)	NR			
	(L)	New facilities clearly identified	NR			
	(M)	Necessary support facilities required for complete functional project (warehouse, igloo, fuel storage, waste treatment, etc.)	R	B/C		
C-4	B-2	Subsoil conditions (actual or expected—groundwater, permafrost, etc.)	NR			
B-2	B-3	Real estate actions (acquisition, disposal, lease, right-of-way)	NR			
B-3	B-4	Demolition/relocation required to clear site (date)	NR			
B-4	B-5	Pavement types and requirements				
	(A)	Design loading and use frequency by type of paving	NR			
	(B)	Street size and layout (traffic control)	NR			
	(C)	Parking lots (signage, etc.)	NR			
	(D)	Sidewalks and curbs (handicapped, etc.)	NR			
	(E)	Gutters, culverts and other drainage factors	NR			
	(F)	Runways, aprons and taxiways	NR			
	(G)	Tie-down anchors or grounds	NR			
	(H)	Special surface conditions required	NR			
D-9, D-10	B-6	Energy conservation siting and features (wind solar, etc.). See also DDC Item D-13 (D) & (E)	NR			

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design data checklist

DA FORM 5025-B-1-R, Feb 82

See Tech. Data Checklist Item	B. SITE DEVELOPMENT (Continued) ITEM		Required or Not Required	To Be Determined *	Comment Attached	Document Attached
B-5	B-7	Landscape treatment				
	(A)	Preservation of existing features	NR			
	(B)	Proposed planting (low maintenance species, locations away from power lines, etc.)	NR			
B-5	B-8	Storm drainage (See also Item E-4)				
	(A)	Total run-off area affecting project	NR			
	(B)	Design intensity for floods	NR			
	(C)	Design of storm drainage system to include pick-up system and outfall lines	NR			
	B-9	Consideration of Coastal Zone Management Act (PL 92-583, 1972; Amendment PL 94-370, 1976)	NR			
		Other Site Development Considerations (List and number items)				

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design data checklist

DA FORM 5025-B-2-R, Feb 82

See Tech. Data Checklist Item	C. ARCHITECTURAL & STRUCTURAL — ITEM		Required or Not Required	• To Be Determined	Comment Attached	Document Attached
	C-1	Material availability limitations (include fill and paving)	NR			
	C-2	Architectural style (existing, planned or desired, use of pre-engineered buildings considered)	NR			
C-7	C-3	Floors (type, finish, special loading, subgrade moisture control, low maintenance types particularly in spill areas)	NR			
C-3	C-4	Walls	NR			
	(A)	Exterior (materials, sealing of joints, general maintenance)	NR			
	(B)	Interior walls and partitions (material, finish, fire resistance, subgrade moisture control)	NR			
	C-5	Ceilings (height, finish, acoustics)	NR			
	C-6	Windows (type, size, special treatment)	NR			
	C-7	Doors (type, size, power operation, panic hardware, durability)	NR			
	C-8	Hardware (finish, location, special metal restrictions, durability)	NR			
	C-9	Special finishes (protective coatings, non-sparking, conductive, acid-resistant)	NR			
C-8	C-10	Security features (windows, doors, hardware, construction of walls, floors & ceilings, arms rooms, vaults, etc.)	NR			
	C-11	Sound attenuation requirements (expected and required levels, location)	NR			
	C-12	Stairs, elevators and chutes (location, size, type of usage)	NR			
	C-13	Loading docks and canopies	NR			
C-1	C-14	Vibration-producing equipment requiring isolation	NR			
C-4	C-15	Unusual foundation requirements (pier, pile, caisson, deep foundations, mat, special treatment, creep control)	NR			
	C-16	Span or unusual clearance requirements (span or height)	NR			
	C-17	Special bay sizes (reflect access dimensions)	NR			
	C-18	Overhead support requirements (hoists, cranes)	NR			
C-7	C-19	Roof loads and requirements (live/dead loads, materials, access, low maintenance features like exterior drains, etc.)	NR			
	C-20	Structural specialities (slabs, sumps, trenches, pits)	NR			
C-2	C-21	Seismic zone design criteria	NR			
C-2	C-22	Area wind loads (summer/winter prevailing wind, hurricane, typhoon)	NR			
C-3	C-23	Protective shelter evaluation and resistant design criteria	NR			
	(A)	Explosive/nuclear blast (protective, resistive, suppressive, venting and containment structures)	NR			
	(B)	Radiation protection (type of radiation, intensity, source)	NR			
	(C)	Chemical/biological protection	NR			

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design data checklist

DA FORM 5025-C-1-R, Feb 82

See Tech. Data Checklist Item	C. ARCHITECTURAL & STRUCTURAL (Continued) ITEM		Required or Not Required	To Be Determined*	Comment Attached	Document Attached
C-5	C-24	Designation and strength of units to be accommodated	NR			
C-6	C-25	Requirements for special design projects	NR			
	C-26	Safety features (occupant load, maximum travel distance to exits, hazard to be controlled or eliminated)	NR			
	C-27	Special design features for handicapped.	NR			
		Other Architectural and Structural (list and number items)				

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design data checklist

DA FORM 5025-C-2-R, Feb 82

See Tech. Data Checklist Item		D. MECHANICAL, ELECTRICAL, & UTILITY SYSTEMS ITEM	Required or Not Required	To Be Determined*	Comment Attached	Document Attached
D-1	D-1	Special mechanical requirements or considerations	R	D		
D-2	D-2	Special peak usage periods and peak leveling techniques	NR			
D-3	D-3	Maintenance considerations (equipment room size, layout, location, general accessibility of equipment, compatibility with existing equipment.)	R	D		
D-9	D-4	Energy monitoring control system (EMCS) and permanent utilities metering	NR			
D-4	D-5	Plumbing system (proposed and/or existing)	NR			
	(A)	General piping and storage system				
	(1)	Materials (galvanized, copper, etc.)				
	(2)	Insulation				
	(3)	Natural or LP gas				
	(4)	Venting				
	(5)	Distilled water				
	(6)	Compressed air				
	(7)	Hospital & surgical gases				
	(8)	Other (chemical, fuel)				
	(B)	Facility water supply				
	(C)	Garbage disposal				
	(D)	Sanitary drainage system				
	(E)	Grease interception				
	(F)	Chemical waste drainage & disposal (incl. explosive process waste)				
	(G)	Radioactive waste				
	(H)	Drinking fountains				
	(I)	Water treatment				
	(J)	Emergency fixtures (showers, eyewash fountains)				
D-5	D-6	Heating system		B		
	(A)	Existing generation plant		B		
	(1)	Location and distance from new facility		B		
	(2)	Equipment (type, age, fuel, etc.)		B		
	(3)	Current loads (average, peak, reserves for this and other projects, load leveling system)		B		
	(4)	Type of plant		B		
	(5)	Manning & support requirements		B		
	(6)	Pollution controls		B		
	(7)	Type of product		B		

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design data checklist

DA FORM 5025-D-1-R, Feb 82

D. MECHANICAL, ELECTRICAL, & UTILITY SYSTEMS (Continued)

See Tech. Data Checklist Item		ITEM	Required or Not Required	* To Be Determined	Comment Attached	Document Attached
D-5	D-6	Heating system (continued)	NR			
	(B)	Requirements for proposed facility				
	(1)	Type of system				
	(2)	Heat load requirements (special temperature demands)				
	(3)	Controls, metering & EMCS requirements				
	(4)	Distribution system (valves, steam pressure, fluid temperature)				
	(5)	Corrosion control				
	(6)	Insulation				
	(7)	Additional equipment specifications				
D-6	D-7	Ventilating/air conditioning/refrigeration system				
	(A)	Existing facilities	NR			
	(1)	Location				
	(2)	Type of plant (refrigeration, chilled water, etc.)				
	(3)	Current loads (average, peak, reserves for this and other projects, load leveling system)				
	(4)	Type of product (CFM, temperature, GPM, etc.)				
	(5)	Distribution system				
	(6)	Special filtration requirements				
	(7)	Special humidity, ventilation, or temperature requirements				
	(8)	Security restrictions for open ducting				
	(9)	Freezers or coolers				
	(B)	Requirements for proposed facility	R	D		
	(1)	Type of system		D		
	(2)	Temperature, humidity and vent conditions special to this design	NR			
	(3)	Control, cycling, metering and EMCS requirements	NR			
	(4)	Distribution (length of extension, location, fluid temperature)	NR			
	(5)	Corrosion control	NR			
	(6)	Insulation		D		
	(7)	Special fire and security considerations for this project	NR			
	(8)	Occupancy hours and days per week	NR			
D-5, D-6	D-8	Heat and chilled water distribution system	NR			
	(A)	Heat system				
	(1)	Type of service				
	(2)	Existing system components				
	(3)	Valving and sectionalizing requirements				
	(4)	Allowable shut-down of service for main connections				
	(5)	Sizing for future facilities				

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design data checklist

DA FORM 5025-D-2-R, Feb 82

See Tech. Data Checklist Item	D. MECHANICAL, ELECTRICAL, & UTILITY SYSTEMS (Continued) ITEM		Required or Not Required	To Be Determined*	Comment Attached	Document Attached
D-5	D-8	Heat and chilled water distribution system (continued)	NR			
D-6	(B)	Chilled water system				
	(1)	Type of service				
	(2)	Existing system components				
	(3)	Valving and sectionalizing requirements				
	(4)	Allowable shut-down of service for main connections				
	(5)	Sizing for future facilities				
D-7	D-9	Electrical system		B		
	(A)	Power service characteristics & location		B		
	(B)	Stand-by power (available & required)	NR			
	(C)	Special interior functional lighting requirements (brightness, night, emergency, justification)	NR			
	(D)	Uninterruptible power required	NR			
	(E)	Commercial tie-in requirements & restrictions	NR			
	(F)	Potential for increased power service needed	NR			
	(G)	Service outage duration limitations	NR			
	(H)	Security alarm systems (type & location)	NR			
	(I)	Street, parking or security lighting (brightness, hours, switching, etc.)	NR			
	(J)	Types of fixtures required (including mounting, NEC classification, etc.)	NR			
	(K)	Telephone extension circuits or conduit (functional support & outlet location)	NR			
	(L)	Television circuitsor conduit (functional support & outlet location)	NR			
	(M)	Intercom requirements (locations, type)		B		
	(N)	Equipment list w/power requirements		D		
	(O)	Special communications requirements (filtering, maximum fluctuation limitations, convertors, etc.)	NR			
	(P)	Electronic shielding & interference measures (frequency involved)	NR			
	(Q)	Special switches & control outlets, receptacle requirements, etc.		D		
	(R)	Grounding requirements, lightning protection	NR			
	(S)	Hazardous environment requirements (location, activity involved, NEC classification, type of hazard)	NR			
	(T)	Corrosion control (cathodic protection)	NR			

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design data checklist

DA FORM 5025-D-3-R, Feb 82

See Tech. Data Checklist Item	D. MECHANICAL, ELECTRICAL, & UTILITY SYSTEMS (Continued) ITEM		Required or Not Required	To Be Determined*	Comment Attached	Document Attached
D-7	D-9	Electrical system (continued)				
	(U)	Other special power requirements (traffic control, antenna, etc.)	NR			
	(V)	Applicability of task lighting considerations	NR			
	(W)	Power management and metering requirements	NR			
	D-10	Electrical Distribution	NR			
	(A)	Actual & estimated loads (peak & average (KW demand))				
	(B)	Utility compnay distribution system (substations, transmission lines, rate schedule, etc.)				
	(C)	Government owned distribution system (switching station, transmission lines, feeders, etc.)				
	(D)	Estimated impact of proposed equipment installation on power factor, load balance and costs for corrective action proposed				
	(E)	Overhead/underground (voltage, conductor size, grounding, etc.)				
	(F)	Estimated power demand factor and diversity factor				
	(G)	Power quality requirements (voltage and frequency regulation)				
	(H)	Power to intrusion, detection alarm systems around perimeter				
	D-11	Airfield lighting requirements	NR			
	(A)	Area & location to be served				
	(B)	Source of power (normal & emergency)				
	(C)	Vault requirements				
	(D)	Primary feeders				
	(E)	Control cabling				
	(F)	Runway lighting (centerline, edge, distance markers, intensity control)				
	(G)	Threshold, approach, & strobe beacon lighting				
	(H)	Visual approach slope indicators (VASI)				
	(I)	Obstructions lighting/barrier markers				
	(J)	Taxiway edge lighting				
	(K)	Helipad/heliport lighting (perimeter, landing direction, hoverlane, etc.)				
D-8	D-12	Water supply system	NR			
	(A)	Source (commercial, well, storage, etc.)				
	(B)	Average rate of supply (FPD at PSI) Current & Future				
	(C)	Treatment requirements				
	(D)	Existing system components (type, size, capacity, age, material, location, valving, pressure, etc.)				

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design data checklist

DA FORM 5025-D-4-R, Feb 82

See Tech. Data Checklist Item	D. MECHANICAL, ELECTRICAL, & UTILITY SYSTEMS (Continued) ITEM		Required or Not Required	* To Be Determined	Comment Attached	Document Attached
D-8	D-12	Water supply system (continued)	NR			
	(E)	Chemical analysis of water				
	(F)	Emergency storage requirements				
	(G)	Peak hours of supply (hours & estimated quantity)				
	(H)	Known minimal requirements of supported function or Government equipment (quantity & quality)				
	(I)	Chemical feeder & piping systems				
	(J)	Corrosion control (existing & planned)				
	(K)	Metering or usage restrictions				
	(L)	Location of tie points (available capacity, interruption schedule)				
D-8	D-13	Waste water treatment system	NR			
	(A)	Existing system & components (size, capacity, characteristics)				
	(1)	Treatment plant				
	(2)	Collector sewers				
	(3)	Sewer mains (materials, depth)				
	(4)	Complete treatment — industrial process				
	(5)	Chemical, fuel or oil spill collection facilities				
	(6)	Existing flows (min., avg., peak)				
	(7)	Hydraulic capacity				
	(B)	Known/estimated industrial or functional discharges (quantity & quality)				
	(C)	Contributory population & per capita contribution				
	(D)	Proposed system & components				
	(1)	Treatment plant				
	(2)	Collection sewers				
	(3)	Lift station				
	(4)	Complete treatment (additions or modifications)				
	(5)	Chemical, fuel or oil spill collection facilities				
	(6)	Waste water from portable water treatment plant				
	(7)	Projected flows—average or peak				
	(8)	By-pass restrictions				
	(9)	Location of tie points (available capacity, interruption schedule)				
	(E)	Compliance requirements (federal, state, local)				
	(F)	National Pollution Discharge Elimination System (NPDES) permit				
	(G)	Corrosion control (existing or planned)				

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design data checklist

DA FORM 5025-D-5-R, Feb 82

See Tech. Data Checklist Item	D. MECHANICAL, ELECTRICAL, & UTILITY SYSTEMS (Cont.) ITEM		Required or Not Required	To Be Determined*	Comment Attached	Document Attached
D-9	D-14	Energy Sources				
	(A)	Gas systems (LP, natural, special)	R	D		
	(1)	Loads and areas served	NR			
	(2)	Source of gas & type of service	NR			
	(3)	Supply pressure average	NR			
	(4)	Heating valve & type of gas (BTU per cubic foot)	NR			
	(5)	Valving & sectionalizing criteria	R	D		
	(6)	Pressure regulation — reduction stations	NR			
	(7)	Existing lines, pumping stations, pressurization, base system	NR			
	(8)	Control & metering	NR			
	(B)	POL systems				
	(1)	Fuel (primary or standby source, grade and analysis)	R	D		
	(2)	Storage (tank size, location, type, number of storage days)	R	D		
	(3)	Areas served	NR			
	(4)	Fuel requirements (known, estimated, quantity & type)	NR			
	(5)	Distribution system characteristics (piping, types of fuel, pumps, capacities)	NR			
	(6)	Ventilation system (Vapor Emission Control)	NR			
	(7)	Safety specifications	NR			
	(8)	Filter separators	NR			
	(C)	Coal systems	NR			
	(1)	Storage (location & capacity)				
	(2)	Source of supply (primary & emergency)				
	(3)	Type, energy value, analysis (i.e. sulfur, ash, etc.)				
	(D)	Solar energy systems	NR			
	(1)	Building heating, air conditioning, domestic hot water				
	(2)	Heating process water				
	(3)	Collector type & location				
	(4)	Liquid, chemical or rock storage				
	(5)	Freeze protection				
	(E)	Energy conservation data (U values, orientation, passive solar considerations, etc.)	NR			
		Other Mechanical & Utility Systems (list and number items)				

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design data checklist

DA FORM 5025-D-6-R, Feb 82

E. ENVIRONMENTAL CONSIDERATIONS

See Tech. Data Checklist Item		ITEM	Required or Not Required	To Be Determined*	Comment Attached	Document Attached
E-1	E-1	Water quality	NR			
	(A)	Waste water treatment management program (PL 92-500 & PL 95-217)				
	(B)	Water quality criteria & standards (federal, state and local)				
	(C)	Treatment requirements coordinated with EPA				
	(D)	Facilities to be installed to meet regulatory agency criteria				
E-1	E-2	Air quality				
	(A)	Applicable air quality criteria (federal, state and local; PL 95-95 and Clean Air Act Amendment of 1977)	R	D		
	(B)	Action taken to comply with requirements	R	B		
	(C)	Type & amount of pollutants generated	R	B		
	(D)	Results of proposed abatement measures	NR			
	(E)	Existing control equipment & monitoring procedures	R	B		
E-1	E-3	Solid waste disposal	NR			
	(A)	Applicable solid waste criteria (federal, state and local)				
	(B)	Waste volume generated (type & characteristics)				
	(C)	Method of disposal (land fill and availability of land, leachate, etc.)				
	(D)	Disposition of recyclable materials for reuse or as combustion fuel				
	(E)	Impact on installation recycling programs				
	E-4	Effects of terrain changes (such as excavations, roadways, drainage structures, etc.)	NR			
	(A)	Measures to control erosion	NR			
E-1	E-5	Treatment of hazardous material	NR			
	(A)	Handling and disposal of plychlorinated biphenyls (PCB) in electrical transformers				
	(B)	Handling and disposal of asbestos materials				
	(C)	Handling and disposal of fiberglass products				
	(D)	Storage of fuels and solvents				
	(E)	Coordination with installation spill control plans				
		Other Environmental Considerations (list and number items)				

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DA FORM 5025-E-R, Feb 82

F. FIRE PROTECTION

See Tech. Data Checklist Item	ITEM		Required or Not Required	To Be Determined*	Comment Attached	Document Attached
F-1	F-1	General design guidance	NR			
	(A)	Occupancy type (see NFPA 101, Chap 4)				
	(B)	Water supply characteristics (existing or planned extensions) (capacity, pump activation, storage tanks and pumps, etc.)				
	(C)	Mobile fire apparatus (response distance/time)				
	(D)	Fire detection and alarm systems (existing or planned, type, location, etc.)				
	(E)	Automatic suppression systems (water sprinkler, CO_2, foam etc.—existing or planned				
	(F)	Hazard of contents (low, ordinary, high-see NFPA 101; type—explosives, flammable/toxic chemicals, radioactive materials)				
F-1	F-2	Special fire suppression system requirements	NR			
	(A)	Means of egress				
	(B)	Fire area limitations				
	(C)	Fire walls, partitions, draft curtains				
	(D)	Detection system (type, detectors, supervision, transmitters, annunciators, backup provisions)				
	(E)	Suppression system (damage by water to costly equipment, shut down of operations)				
		Other Fire Protection (list and number items)				

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DA FORM 5025-F-R, Feb 82

Appendix 1 - Calculations/Formulas

MICROSOFT EXCEL PREPARATION

1. Cells of the spreadsheet used for development of baseline and ECO Energy and Annual Cost Data versus equivalent RDX production rate contain either text, constant values, or formulae. Contents of each cell prior to calculation are presented on the following pages.

2. Cells A1 through A156, not reproduced here, contain input text and numerical data, all of which is self explanatory.

3. Where cells shown here contain text and discrete numerical values, the text or numbers are input data.

4. Explanations for formulae shown in the remaining cells are as follows:

Steam Turbine #/hr:	Calculate value from monthly RDX production rate, pounds steam per pound RDX, turbine design steam rate per horsepower, and conversion factors.
Steam Average #/hr:	Conditional tests to select the greater of product driven steam demand, turbine steam demand, or 40,000 lbs/hr, using appropriate conversion factors.
Fuel Million Btu/Mo:	Conditional test to limit coal fired boilers to minimum 40,000 lbs/hr, otherwise calculate value from steam enthalpy difference, monthly RDX production, pounds steam required per pound RDX, and boiler efficiency.
Annual Fuel Cost:	Calculate value from unit fuel cost and calculated fuel million Btu/mo.
Annual Electrical Cost:	Calculate value from assumed electric kWh per thousand pounds of steam, unit cost per kWh and calculated average steam flow rate, plus electric motor energy for pumps and fans when applicable.
Annual Maintenance Cost:	Calculated value from assumed fixed value, assumed variable rate, and calculated steam production rate.
Annual Overhead Cost:	Calculated value from assumed fixed value, assumed variable rate, and calculated steam production rate.
Total Annual Cost:	Summation of individually calculated annual costs.

	B
1	
2	
3	$/MILL.
4	BTU
5	1.86
6	1.86
7	1.86
8	1.86
9	1.86
10	1.86
11	1.86
12	1.86
13	
14	
15	FUEL MILL.
16	BTU/MO
17	=IF(F5=40000,(C5-100)*40000*730*100/(G5*1000000),(C5-100)*A5*D5*100/G5)
18	=IF(F6=40000,(C6-100)*40000*730*100/(G6*1000000),(C6-100)*A6*D6*100/G6)
19	=IF(F7=40000,(C7-100)*40000*730*100/(G7*1000000),(C7-100)*A7*D7*100/G7)
20	=(C8-100)*A8*D8*100/G8
21	=(C9-100)*A9*D9*100/G9
22	=(C10-100)*A10*D10*100/G10
23	=(C11-100)*A11*D11*100/G11
24	=(C12-100)*A12*D12*100/G12
25	
26	
27	
28	$/MILL.
29	BTU
30	1.86
31	1.86
32	1.86
33	1.86
34	1.86
35	1.86
36	1.86
37	1.86
38	
39	
40	FUEL MILL.
41	BTU/MO
42	=IF(F30=40000,(C30-100)*40000*730*100/(G30*1000000),(C30-100)*A30*D30*100/G30)
43	=IF(F31=40000,(C31-100)*40000*730*100/(G31*1000000),(C31-100)*A31*D31*100/G31)
44	=IF(F32=40000,(C32-100)*40000*730*100/(G32*1000000),(C32-100)*A32*D32*100/G32)
45	=(C33-100)*A33*D33*100/G33
46	=(C34-100)*A34*D34*100/G34
47	=(C35-100)*A35*D35*100/G35
48	=(C36-100)*A36*D36*100/G36
49	=(C37-100)*A37*D37*100/G37

	B
50	
51	
52	
53	
54	$/MILL.
55	BTU
56	3.95
57	3.95
58	1.86
59	1.86
60	1.86
61	1.86
62	1.86
63	1.86
64	
65	
66	FUEL MILL.
67	BTU/MO
68	=(C56-100)*A56*D56*100/G56
69	=(C57-100)*A57*D57*100/G57
70	=(C58-100)*A58*D58*100/G58
71	=(C59-100)*A59*D59*100/G59
72	=(C60-100)*A60*D60*100/G60
73	=(C61-100)*A61*D61*100/G61
74	=(C62-100)*A62*D62*100/G62
75	=(C63-100)*A63*D63*100/G63
76	
77	
78	
79	$/MILL.
80	BTU
81	3.95
82	3.95
83	3.95
84	3.95
85	3.95
86	3.95
87	3.95
88	1.86
89	
90	
91	FUEL MILL.
92	BTU/MO
93	=(C81-100)*A81*D81*100/G81
94	=(C82-100)*A82*D82*100/G82
95	=(C83-100)*A83*D83*100/G83
96	=(C84-100)*A84*D84*100/G84
97	=(C85-100)*A85*D85*100/G85
98	=(C86-100)*A86*D86*100/G86

	B
99	=(C87-100)*A87*D87*100/G87
100	=(C88-100)*A88*D88*100/G88
101	
102	
103	
104	$/MILL.
105	BTU
106	3.95
107	3.95
108	3.95
109	3.95
110	3.95
111	3.95
112	3.95
113	1.86
114	
115	
116	FUEL MILL.
117	BTU/MO
118	=(C106-100)*A106*D106*100/G106
119	=(C107-100)*A107*D107*100/G107
120	=(C108-100)*A108*D108*100/G108
121	=(C109-100)*A109*D109*100/G109
122	=(C110-100)*A110*D110*100/G110
123	=(C111-100)*A111*D111*100/G111
124	=(C112-100)*A112*D112*100/G112
125	=(C113-100)*A113*D113*100/G113
126	
127	
128	
129	
130	
131	$/MILL.
132	BTU
133	3.95
134	3.95
135	
136	
137	FUEL MIL.
138	BTU/MO
139	=(C133-100)*A133*D133*100/G133
140	=(C134-100)*A134*D134*100/G134
141	
142	
143	
144	
145	
146	

	B
147	$/MILL.
148	BTU
149	3.95
150	3.95
151	
152	
153	FUEL MIL.
154	BTU/MO
155	=(C149-100)*A149*D149*100/G149
156	=(C150-100)*A150*D150*100/G150

	C
1	
2	
3	STEAM
4	BTU/#
5	1290.2
6	1290.2
7	1290.2
8	1290.2
9	1290.2
10	1290.2
11	1290.2
12	1290.2
13	
14	
15	ANNUAL
16	FUEL COST
17	=B5*B17*12
18	=B6*B18*12
19	=B7*B19*12
20	=B8*B20*12
21	=B9*B21*12
22	=B10*B22*12
23	=B11*B23*12
24	=B12*B24*12
25	
26	
27	
28	STEAM
29	BTU/#
30	1290.2
31	1290.2
32	1290.2
33	1290.2
34	1290.2
35	1290.2
36	1290.2
37	1290.2
38	
39	
40	ANNUAL
41	FUEL COST
42	=B30*B42*12
43	=B31*B43*12
44	=B32*B44*12
45	=B33*B45*12
46	=B34*B46*12
47	=B35*B47*12
48	=B36*B48*12
49	=B37*B49*12

	C
50	
51	
52	
53	
54	STEAM
55	BTU/#
56	1290.2
57	1290.2
58	1290.2
59	1290.2
60	1290.2
61	1290.2
62	1290.2
63	1290.2
64	
65	
66	ANNUAL
67	FUEL COST
68	=B56*B68*12
69	=B57*B69*12
70	=B58*B70*12
71	=B59*B71*12
72	=B60*B72*12
73	=B61*B73*12
74	=B62*B74*12
75	=B63*B75*12
76	
77	
78	
79	STEAM
80	BTU/#
81	1204
82	1204
83	1204
84	1204
85	1204
86	1204
87	1204
88	1290.2
89	
90	
91	ANNUAL
92	FUEL COST
93	=B81*B93*12
94	=B82*B94*12
95	=B83*B95*12
96	=B84*B96*12
97	=B85*B97*12
98	=B86*B98*12

	C
99	=B87*B99*12
100	=B88*B100*12
101	
102	
103	
104	STEAM
105	BTU/#
106	1204
107	1204
108	1204
109	1204
110	1204
111	1204
112	1204
113	1290.2
114	
115	
116	ANNUAL
117	FUEL COST
118	=B106*B118*12
119	=B107*B119*12
120	=B108*B120*12
121	=B109*B121*12
122	=B110*B122*12
123	=B111*B123*12
124	=B112*B124*12
125	=B113*B125*12
126	
127	
128	
129	
130	
131	STEAM
132	BTU/#
133	1187.2
134	1187.2
135	
136	
137	ANNUAL
138	FUEL COST
139	=B133*B139*12
140	=B134*B140*12
141	
142	
143	
144	
145	
146	

	C
147	STEAM
148	BTU/#
149	1187.2
150	1187.2
151	
152	
153	ANNUAL
154	FUEL COST
155	=B149*B155*12
156	=B150*B156*12

	D
1	
2	
3	# STEAM
4	PER #RDX
5	110
6	85
7	65
8	42
9	33
10	20.5
11	13
12	11.5
13	
14	
15	ANNUAL
16	ELECT. COST
17	=2.8*0.035*F5*8760/1000
18	=2.8*0.035*F6*8760/1000
19	=2.8*0.035*F7*8760/1000
20	=2.8*0.035*F8*8760/1000
21	=2.8*0.035*F9*8760/1000
22	=2.8*0.035*F10*8760/1000
23	=2.8*0.035*F11*8760/1000
24	=2.8*0.035*F12*8760/1000
25	
26	
27	
28	# STEAM
29	PER #RDX
30	110
31	85
32	65
33	42
34	33
35	20.5
36	13
37	11.5
38	
39	
40	ANNUAL
41	ELECT. COST
42	=2.8*0.035*F30*8760/1000+(F30/100000)*350*0.035*0.748*8760+0.035*1000*0.748*8760
43	=2.8*0.035*F31*8760/1000+(F31/100000)*350*0.035*0.748*8760+0.035*1000*0.748*8760
44	=2.8*0.035*F32*8760/1000+(F32/100000)*350*0.035*0.748*8760+0.035*1000*0.748*8760
45	=2.8*0.035*F33*8760/1000+(F33/100000)*350*0.035*0.748*8760+0.035*1000*0.748*8760
46	=2.8*0.035*F34*8760/1000+(F34/100000)*700*0.035*0.748*8760+0.035*1000*0.748*8760
47	=2.8*0.035*F35*8760/1000+(F35/100000)*700*0.035*0.748*8760+0.035*2000*0.748*8760
48	=2.8*0.035*F36*8760/1000+(F36/100000)*1050*0.035*0.748*8760+0.035*3000*0.748*8760
49	[illegible].8*0.035*F37*8760/1000+(F37/100000)*1400*0.035*0.748*8760+0.035*3000*0.748*8760

	D
5	
5	
52	
53	
54	# STEAM
55	PER #RDX
56	110
57	85
58	65
59	42
60	33
61	20.5
62	13
63	11.5
64	
65	
66	ANNUAL
67	ELECT. COST
68	=2.8*0.035*F56*8760/1000+(F56/100000)*350*0.035*0.748*8760+0.035*1000*0.748*8760
69	=2.8*0.035*F57*8760/1000+(F57/100000)*350*0.035*0.748*8760+0.035*1000*0.748*8760
70	=2.8*0.035*F58*8760/1000+(F58/100000)*350*0.035*0.748*8760+0.035*1000*0.748*8760
71	=2.8*0.035*F59*8760/1000+(F59/100000)*350*0.035*0.748*8760+0.035*1000*0.748*8760
72	=2.8*0.035*F60*8760/1000+(F60/100000)*700*0.035*0.748*8760+0.035*1000*0.748*8760
73	=2.8*0.035*F61*8760/1000+(F61/100000)*700*0.035*0.748*8760+0.035*2000*0.748*8760
7	2.8*0.035*F62*8760/1000+(F62/100000)*1050*0.035*0.748*8760+0.035*3000*0.748*8760
7	=2.8*0.035*F63*8760/1000+(F63/100000)*1400*0.035*0.748*8760+0.035*3000*0.748*8760
76	
77	
78	
79	# STEAM
80	PER #RDX
81	=(1290.2-100)/(1204-100)*D5-(F5*20.6*350/100000)/(A81*1000000)
82	=(1290.2-100)/(1204-100)*D6-(F6*20.6*350/100000)/(A82*1000000)
83	=(1290.2-100)/(1204-100)*D7-(F7*20.6*350/100000)/(A83*1000000)
84	=(1290.2-100)/(1204-100)*D8-(F8*20.6*350/100000)/(A84*1000000)
85	=(1290.2-100)/(1204-100)*D9-(F9*20.6*350/100000)/(A85*1000000)
86	=(1290.2-100)/(1204-100)*D10-(F10*20.6*350/100000)/(A86*1000000)
87	=(1290.2-100)/(1204-100)*D11-(F11*20.6*350/100000)/(A87*1000000)
88	11.5
89	
90	
91	ANNUAL
92	ELECT. COST
93	=0.95*0.035*F81*8760/1000+0.035*200*0.748*8760
94	=0.95*0.035*F82*8760/1000+0.035*200*0.748*8760
95	=0.95*0.035*F83*8760/1000+0.035*200*0.748*8760
96	=0.95*0.035*F84*8760/1000+0.035*200*0.748*8760
97	=0.95*0.035*F85*8760/1000+0.035*200*0.748*8760
9	.95*0.035*F86*8760/1000+0.035*200*0.748*8760

	D
99	=0.95*0.035*F87*8760/1000+0.035*200*0.748*8760
100	=2.8*0.035*F88*8760/1000+(F88/100000)*1400*0.035*0.748*8760+0.035*3000*0.748*8760
101	
102	
103	
104	# STEAM
105	PER #RDX
106	=(1290.2-100)/(1204-100)*D30-(F30*20.6*350/100000)/(A106*1000000)
107	=(1290.2-100)/(1204-100)*D31-(F31*20.6*350/100000)/(A107*1000000)
108	=(1290.2-100)/(1204-100)*D32-(F32*20.6*350/100000)/(A108*1000000)
109	=(1290.2-100)/(1204-100)*D33-(F33*20.6*350/100000)/(A109*1000000)
110	=(1290.2-100)/(1204-100)*D34-(F34*20.6*350/100000)/(A110*1000000)
111	=(1290.2-100)/(1204-100)*D35-(F35*20.6*350/100000)/(A111*1000000)
112	=(1290.2-100)/(1204-100)*D36-(F36*20.6*350/100000)/(A112*1000000)
113	11.5
114	
115	
116	ANNUAL
117	ELECT. COST
118	=0.95*0.035*F106*8760/1000+0.035*200*0.748*8760+0.035*1350*0.748*8760
119	=0.95*0.035*F107*8760/1000+0.035*200*0.748*8760+0.035*1350*0.748*8760
120	=0.95*0.035*F108*8760/1000+0.035*200*0.748*8760+0.035*1350*0.748*8760
121	=0.95*0.035*F109*8760/1000+0.035*200*0.748*8760+0.035*1350*0.748*8760
122	=0.95*0.035*F110*8760/1000+0.035*200*0.748*8760+0.035*1350*0.748*8760
123	=0.95*0.035*F111*8760/1000+0.035*200*0.748*8760+0.035*1350*0.748*8760
124	=0.95*0.035*F112*8760/1000+0.035*200*0.748*8760+0.035*1350*0.748*8760
125	=2.8*0.035*F113*8760/1000+(F113/100000)*1400*0.035*0.748*8760+0.035*3000*0.748*8760
126	
127	
128	
129	
130	
131	# STEAM
132	PER #RDX
133	=(1290.2-100)/(1187.2-100)*D56-(F56*20.6*350/100000)/(A133*1000000)
134	=(1290.2-100)/(1187.2-100)*D57-(F57*20.6*350/100000)/(A134*1000000)
135	
136	
137	ANNUAL
138	ELECT. COST
139	=0.95*0.035*F133*8760/1000+0.035*75*0.748*8760+0.035*1350*0.748*8760
140	=0.95*0.035*F134*8760/1000+0.035*75*0.748*8760+0.035*1350*0.748*8760
141	
142	
143	
144	
145	
146	

	D
147	# STEAM
148	PER #RDX
149	=(1290.2-100)/(1187.2-100)*D56-(F56*20.6*350/100000)/(A149*1000000)
150	=(1290.2-100)/(1187.2-100)*D57-(F57*20.6*350/100000)/(A150*1000000)
15[illegible]	
15[illegible]	
153	ANNUAL
154	ELECT. COST
155	=0.95*0.035*F149*8760/1000+0.035*75*0.748*8760+0.035*1350*0.748*8760
156	=0.95*0.035*F150*8760/1000+0.035*75*0.748*8760+0.035*1350*0.748*8760

	E
[illegible]	
2	
3	STEAM TURB-
4	INE #/HR
5	=(A5*D5*1000000/100000)*20.6*700/730+35.5*1000
6	=(A6*D6*1000000/100000)*20.6*700/730+35.5*1000
7	=(A7*D7*1000000/100000)*20.6*700/730+35.5*1000
8	=(A8*D8*1000000/100000)*20.6*700/730+35.5*1000
9	=(A9*D9*1000000/100000)*20.6*1400/730+35.5*1000
10	=(A10*D10*1000000/100000)*20.6*1400/730+35.5*1000
11	=(A11*D11*1000000/100000)*20.6*2100/730+35.5*1000
12	=(A12*D12*1000000/100000)*20.6*2800/730+35.5*1000
13	
14	
15	ANNUAL;
16	MNTNC. COST
17	=37500*12+(0.5*F5*8760/1000)
18	=37500*12+(0.5*F6*8760/1000)
19	=37500*12+(0.5*F7*8760/1000)
20	=37500*12+(0.5*F8*8760/1000)
21	=37500*12+(0.5*F9*8760/1000)
22	=37500*12+(0.5*F10*8760/1000)
23	=37500*12+(0.5*F11*8760/1000)
24	=37500*12+(0.5*F12*8760/1000)
2[illegible]	
26	
27	
28	STEAM TURB-
29	INE #/HR
30	=(A30*D30*1000000/100000)*20.6*350/730
31	=(A31*D31*1000000/100000)*20.6*350/730
32	=(A32*D32*1000000/100000)*20.6*350/730
33	=(A33*D33*1000000/100000)*20.6*350/730
34	=(A34*D34*1000000/100000)*20.6*700/730
35	=(A35*D35*1000000/100000)*20.6*700/730
36	=(A36*D36*1000000/100000)*20.6*1050/730
37	=(A37*D37*1000000/100000)*20.6*1400/730
38	
39	
40	ANNUAL;
41	MNTNC. COST
42	=12*37500+(0.5*F30*8760/1000)
43	=12*37500+(0.5*F31*8760/1000)
44	=12*37500+(0.5*F32*8760/1000)
45	=12*37500+(0.5*F33*8760/1000)
46	=12*37500+(0.5*F34*8760/1000)
47	=12*37500+(0.5*F35*8760/1000)
4[illegible]	[illegible]2*37500+(0.5*F36*8760/1000)
4[illegible]	[illegible]2*37500+(0.5*F37*8760/1000)

	E
5[illegible]	
51	
52	
53	
54	STEAM TURB-
55	INE #/HR
56	=(A56*D56*1000000/100000)*20.6*350/730
57	=(A57*D57*1000000/100000)*20.6*350/730
58	=(A58*D58*1000000/100000)*20.6*350/730
59	=(A59*D59*1000000/100000)*20.6*350/730
60	=(A60*D60*1000000/100000)*20.6*700/730
61	=(A61*D61*1000000/100000)*20.6*700/730
62	=(A62*D62*1000000/100000)*20.6*1050/730
63	=(A63*D63*1000000/100000)*20.6*1400/730
64	
65	
66	ANNUAL;
67	MNTNC. COST
68	=12*37500+(0.5*F56*8760/1000)
69	=12*37500+(0.5*F57*8760/1000)
70	=12*37500+(0.5*F58*8760/1000)
71	=12*37500+(0.5*F59*8760/1000)
72	=12*37500+(0.5*F60*8760/1000)
73	=12*37500+(0.5*F61*8760/1000)
7[illegible]	[illegible]2*37500+(0.5*F62*8760/1000)
75	[illegible]12*37500+(0.5*F63*8760/1000)
76	
77	
78	
79	STEAM TURB-
80	INE #/HR
81	=(A81*D81*1000000/100000)*20.6*350/730+35.5*1000
82	=(A82*D82*1000000/100000)*20.6*350/730+35.5*1000
83	=(A83*D83*1000000/100000)*20.6*350/730+35.5*1000
84	=(A84*D84*1000000/100000)*20.6*350/730+35.5*1000
85	=(A85*D85*1000000/100000)*20.6*700/730+35.5*1000
86	=(A86*D86*1000000/100000)*20.6*700/730+35.5*1000
87	=(A87*D87*1000000/100000)*20.6*1050/730+35.5*2000
88	=(A88*D88*1000000/100000)*20.6*1400/730
89	
90	
91	ANNUAL;
92	MNTNC. COST
93	=18750*12+(0.15*F81*8760/1000)
94	=18750*12+(0.15*F82*8760/1000)
95	=18750*12+(0.15*F83*8760/1000)
96	=18750*12+(0.15*F84*8760/1000)
97	=18750*12+(0.15*F85*8760/1000)
9[illegible]	[illegible]8750*12+(0.15*F86*8760/1000)

	E
99	=18750*12+(0.15*F87*8760/1000)
100	=12*37500+(0.5*F88*8760/1000)
101	
102	
103	
104	STEAM TURB-
105	INE #/HR
106	0
107	0
108	0
109	0
110	0
111	0
112	0
113	=(A113*D113*1000000/100000)*20.6*1400/730
114	
115	
116	ANNUAL;
117	MNTNC. COST
118	=18750*12+(0.15*F106*8760/1000)
119	=18750*12+(0.15*F107*8760/1000)
120	=18750*12+(0.15*F108*8760/1000)
121	=18750*12+(0.15*F109*8760/1000)
122	=18750*12+(0.15*F110*8760/1000)
123	=18750*12+(0.15*F111*8760/1000)
124	=18750*12+(0.15*F112*8760/1000)
125	=12*37500+(0.5*F113*8760/1000)
126	
127	
128	
129	
130	
131	STEAM TURB-
132	INE #/HR
133	0
134	0
135	
136	
137	ANNUAL;
138	MNTNC. COST
139	=3750*12+(0.15*F133*8760/1000)
140	=3750*12+(0.15*F134*8760/1000)
141	
142	
143	
144	
145	
146	

	E
147	STEAM TURB-
148	INE #/HR
149	0
150	0
1[illegible]	
1[illegible]	
153	ANNUAL;
154	MNTNC. COST
155	=6250*12+(0.15*F149*8760/1000)
156	=6250*12+(0.15*F150*8760/1000)

	F
1	
2	
3	STEAM
4	AVG.#/HR
5	=IF(E5<40000,IF(A5*D5*1000000/730<40000,40000,A5*D5*1000000/730),IF(E5>A5*D5*1000000/730,E5,A5*D5*1000000/
6	=IF(E6<40000,IF(A6*D6*1000000/730<40000,40000,A6*D6*1000000/730),IF(E6>A6*D6*1000000/730,E6,A6*D6*1000000/
7	=IF(E7<40000,IF(A7*D7*1000000/730<40000,40000,A7*D7*1000000/730),IF(E7>A7*D7*1000000/730,E7,A7*D7*1000000/
8	=IF(E8<40000,IF(A8*D8*1000000/730<40000,40000,A8*D8*1000000/730),IF(E8>A8*D8*1000000/730,E8,A8*D8*1000000/
9	=IF(E9<40000,IF(A9*D9*1000000/730<40000,40000,A9*D9*1000000/730),IF(E9>A9*D9*1000000/730,E9,A9*D9*1000000/
10	=IF(E10<40000,IF(A10*D10*1000000/730<40000,40000,A10*D10*1000000/730),IF(E10>A10*D10*1000000/730,E10,A10*
11	=IF(E11<40000,IF(A11*D11*1000000/730<40000,40000,A11*D11*1000000/730),IF(E11>A11*D11*1000000/730,E11,A11*
12	=IF(E12<40000,IF(A12*D12*1000000/730<40000,40000,A12*D12*1000000/730),IF(E12>A12*D12*1000000/730,E12,A12*
13	
14	
15	ANNUAL
16	OVRHD. COST
17	=70000*12+(0.25*F5*8760/1000)
18	=70000*12+(0.25*F6*8760/1000)
19	=70000*12+(0.25*F7*8760/1000)
20	=70000*12+(0.25*F8*8760/1000)
21	=70000*12+(0.25*F9*8760/1000)
22	=70000*12+(0.25*F10*8760/1000)
23	=70000*12+(0.25*F11*8760/1000)
24	=70000*12+(0.25*F12*8760/1000)
25	
26	
27	
28	STEAM
29	AVG.#/HR
30	=IF(E30<40000,IF(A30*D30*1000000/730<40000,40000,A30*D30*1000000/730),IF(E30>A30*D30*1000000/730,E30,A30*
31	=IF(E31<40000,IF(A31*D31*1000000/730<40000,40000,A31*D31*1000000/730),IF(E31>A31*D31*1000000/730,E31,A31*
32	=IF(E32<40000,IF(A32*D32*1000000/730<40000,40000,A32*D32*1000000/730),IF(E32>A32*D32*1000000/730,E32,A32*
33	=IF(E33<40000,IF(A33*D33*1000000/730<40000,40000,A33*D33*1000000/730),IF(E33>A33*D33*1000000/730,E33,A33*
34	=IF(E34<40000,IF(A34*D34*1000000/730<40000,40000,A34*D34*1000000/730),IF(E34>A34*D34*1000000/730,E34,A34*
35	=IF(E35<40000,IF(A35*D35*1000000/730<40000,40000,A35*D35*1000000/730),IF(E35>A35*D35*1000000/730,E35,A35*
36	=IF(E36<40000,IF(A36*D36*1000000/730<40000,40000,A36*D36*1000000/730),IF(E36>A36*D36*1000000/730,E36,A36*
37	=IF(E37<40000,IF(A37*D37*1000000/730<40000,40000,A37*D37*1000000/730),IF(E37>A37*D37*1000000/730,E37,A37*
38	
39	
40	ANNUAL
41	OVRHD. COST
42	=70000*12+(0.25*F30*8760/1000)
43	=70000*12+(0.25*F31*8760/1000)
44	=70000*12+(0.25*F32*8760/1000)
45	=70000*12+(0.25*F33*8760/1000)
46	=70000*12+(0.25*F34*8760/1000)
47	=70000*12+(0.25*F35*8760/1000)
48	=70000*12+(0.25*F36*8760/1000)
49	=70000*12+(0.25*F37*8760/1000)

	F
5[illegible]	
5[illegible]	
52	
53	
54	STEAM
55	AVG.#/HR
56	=D56*A56*1000000/730
57	=D57*A57*1000000/730
58	=D58*A58*1000000/730
59	=D59*A59*1000000/730
60	=D60*A60*1000000/730
61	=D61*A61*1000000/730
62	=D62*A62*1000000/730
63	=D63*A63*1000000/730
64	
65	
66	ANNUAL
67	OVRHD. COST
68	=70000*12+(0.25*F56*8760/1000)
69	=70000*12+(0.25*F57*8760/1000)
70	=70000*12+(0.25*F58*8760/1000)
71	=70000*12+(0.25*F59*8760/1000)
72	=70000*12+(0.25*F60*8760/1000)
73	=70000*12+(0.25*F61*8760/1000)
7[illegible]	[illegible]0000*12+(0.25*F62*8760/1000)
7[illegible]	[illegible]70000*12+(0.25*F63*8760/1000)
76	
77	
78	
79	STEAM
80	AVG.#/HR
81	=IF((A81*D81*1000000/100000)*20.6*350/730+35.5*1000>A81*D81*1000000/730,(A81*D81*1000000/100000)*20.6*350/73
82	=IF((A82*D82*1000000/100000)*20.6*350/730+35.5*1000>A82*D82*1000000/730,(A82*D82*1000000/100000)*20.6*350/73
83	=IF((A83*D83*1000000/100000)*20.6*350/730+35.5*1000>A83*D83*1000000/730,(A83*D83*1000000/100000)*20.6*350/73
84	=IF((A84*D84*1000000/100000)*20.6*350/730+35.5*1000>A84*D84*1000000/730,(A84*D84*1000000/100000)*20.6*350/73
85	=IF((A85*D85*1000000/100000)*20.6*350/730+35.5*1000>A85*D85*1000000/730,(A85*D85*1000000/100000)*20.6*350/73
86	=IF((A86*D86*1000000/100000)*20.6*350/730+35.5*1000>A86*D86*1000000/730,(A86*D86*1000000/100000)*20.6*350/73
87	=IF((A87*D87*1000000/100000)*20.6*350/730+35.5*1000>A87*D87*1000000/730,(A87*D87*1000000/100000)*20.6*350/73
88	=D88*A88*1000000/730
89	
90	
91	ANNUAL
92	OVRHD. COST
93	=70000*12+(0.25*F81*8760/1000)
94	=70000*12+(0.25*F82*8760/1000)
95	=70000*12+(0.25*F83*8760/1000)
96	=70000*12+(0.25*F84*8760/1000)
97	=70000*12+(0.25*F85*8760/1000)
9[illegible]	[illegible]0000*12+(0.25*F86*8760/1000)

	F
99	=70000*12+(0.25*F87*8760/1000)
100	=70000*12+(0.25*F88*8760/1000)
101	
102	
103	
104	STEAM
105	AVG.#/HR
106	=A106*D106*1000000/730
107	=A107*D107*1000000/730
108	=A108*D108*1000000/730
109	=A109*D109*1000000/730
110	=A110*D110*1000000/730
111	=A111*D111*1000000/730
112	=A112*D112*1000000/730
113	=D113*A113*1000000/730
114	
115	
116	ANNUAL
117	OVRHD. COST
118	=70000*12+(0.25*F106*8760/1000)
119	=70000*12+(0.25*F107*8760/1000)
120	=70000*12+(0.25*F108*8760/1000)
121	=70000*12+(0.25*F109*8760/1000)
122	=70000*12+(0.25*F110*8760/1000)
123	=70000*12+(0.25*F111*8760/1000)
124	=70000*12+(0.25*F112*8760/1000)
125	=70000*12+(0.25*F113*8760/1000)
126	
127	
128	
129	
130	
131	STEAM
132	AVG.#/HR
133	=A133*D133*1000000/730
134	=A134*D134*1000000/730
135	
136	
137	ANNUAL
138	OVRHD. CST
139	=35000*12+(0.25*F133*8760/1000)
140	=35000*12+(0.25*F134*8760/1000)
141	
142	
143	
144	
145	
146	

	F
147	STEAM
148	AVG.#/HR
149	=A149*D149*1000000/730
150	=A150*D150*1000000/730
15[illegible]	
1[illegible]	
153	ANNUAL
154	OVRHD. CST
155	=50000*12+(0.25*F149*8760/1000)
156	=50000*12+(0.25*F150*8760/1000)

	G
1	
2	
3	BOILER
4	EFFIC.
5	75
6	75
7	80.7
8	79.5
9	77.2
10	79.2
11	82.1
12	82.9
13	
14	
15	TOTAL
16	ANNUAL COST
17	=C17+D17+E17+F17
18	=C18+D18+E18+F18
19	=C19+D19+E19+F19
20	=C20+D20+E20+F20
21	=C21+D21+E21+F21
22	=C22+D22+E22+F22
23	=C23+D23+E23+F23
24	=C24+D24+E24+F24
25	
26	
27	
28	BOILER
29	EFFIC.
30	75
31	75
32	77.5
33	78.1
34	83.2
35	78.2
36	81
37	83.2
38	
39	
40	TOTAL
41	ANNUAL COST
42	=C42+D42+E42+F42
43	=C43+D43+E43+F43
44	=C44+D44+E44+F44
45	=C45+D45+E45+F45
46	=C46+D46+E46+F46
47	=C47+D47+E47+F47
48	=C48+D48+E48+F48
49	=C49+D49+E49+F49

	G
50	
51	
52	
53	
54	BOILER
55	EFFIC.
56	77
57	77.9
58	76.8
59	78
60	83.1
61	78
62	79
63	82
64	
65	
66	TOTAL
67	ANNUAL COST
68	=C68+D68+E68+F68
69	=C69+D69+E69+F69
70	=C70+D70+E70+F70
71	=C71+D71+E71+F71
72	=C72+D72+E72+F72
73	=C73+D73+E73+F73
74	=C74+D74+E74+F74
75	=C75+D75+E75+F75
76	
77	
78	
79	BOILER
80	EFFIC.
81	78
82	78.5
83	81
84	81.8
85	82.5
86	83.2
87	82
88	82
89	
90	
91	TOTAL
92	ANNUAL COST
93	=C93+D93+E93+F93
94	=C94+D94+E94+F94
95	=C95+D95+E94+F95
96	=C96+D96+E96+F96
97	=C97+D97+E97+F97
98	=C98+D98+E98+F98

	G
99	=C99+D99+E99+F99
100	=C100+D100+E100+F100
101	
102	
103	
104	BOILER
105	EFFIC.
106	78
107	78.5
108	81
109	81.8
110	82.5
111	83.2
112	82
113	82
114	
115	
116	TOTAL
117	ANNUAL COST
118	=C118+D118+E118+F118
119	=C119+D119+E119+F119
120	=C120+D120+E119+F120
121	=C121+D121+E121+F121
122	=C122+D122+E122+F122
123	=C123+D123+E123+F123
124	=C124+D124+E124+F124
125	=C125+D125+E125+F125
126	
127	
128	
129	
130	
131	BOILER
132	EFFIC.
133	84.5
134	84.5
135	
136	
137	TOTAL
138	ANNUAL COST
139	=C139+D139+E139+F139
140	=C140+D140+E140+F140
141	
142	
143	
144	
145	
146	

	G
147	BOILER
148	EFFIC.
149	84.5
150	84.5
151	
152	
153	TOTAL
154	ANNUAL COST
155	=C155+D155+E155+F155
156	=C156+D156+E156+F156

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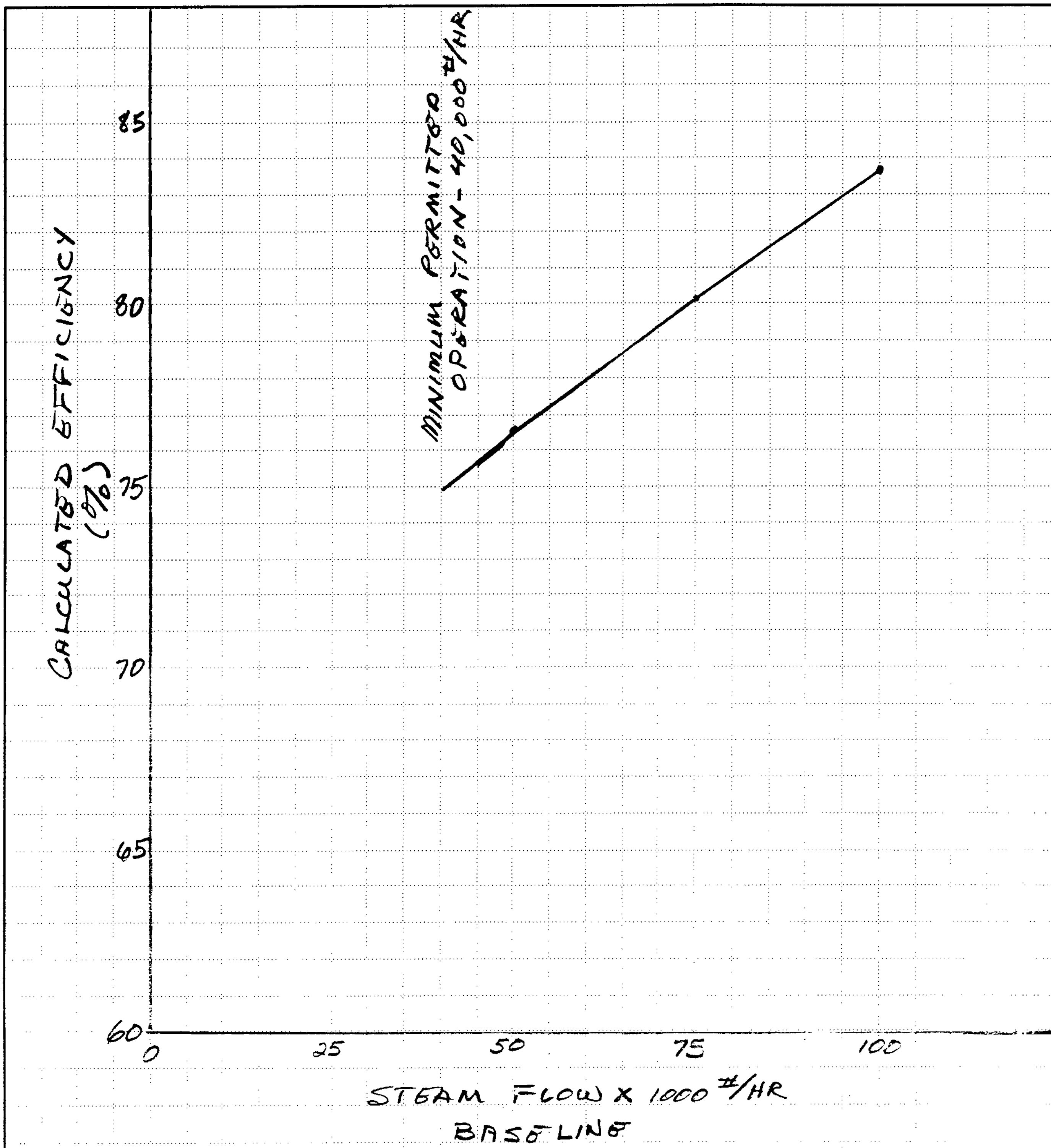
	Checked By:	Date:	Sheet No: 1 of 4

Calculations For: BASELINE CONDITIONS - CASE 1 & 2 BLR. EFF.



95046-00

COMBUSTION CALCULATIONS

100,000 #/HR LOAD

BASED ON QUANTITIES PER 10,000 BTU FUEL INPUT

BASE CASE 1&2

LINE			LINE
1	FUEL— COAL	CONDITIONS DATE	a
2	ANALYSIS AS FIRED	BY TEST OR SPECIFICATION 8-16-95	
3	ULTIMATE, % BY WT / PROXIMATE, % BY WT	TOTAL AIR % 170	b
4	C 74.7 / MOISTURE 2.9	AIR TEMPERATURE TO HEATER F 80	c
5	H_2 5.3 / VOLATILE 34.7	AIR TEMPERATURE FROM HEATER F —	d
6	S 0.7 / FIXED CARBON 56.1	FLUE GAS TEMPERATURE LEAVING UNIT F 375	e
7	O_2 8.5 / ASH 6.3	H_2O PER LB DRY AIR LB 0.0132	f
8	N_2 1.6		g
9	H_2O 2.9	UNBURNED FUEL LOSS % 0	h
10	ASH 6.3	UNACCOUNTED LOSS % 2.5	i
11		RADIATION LOSS (ABAI), FIG. 20, CHAPTER 7 % 0.75	j
12	BTU PER LB, AS FIRED, 14000 B/#		k

LINE	QUANTITIES PER 10,000 BTU FUEL INPUT	UNIT	VALUE	LINE
14	FUEL BURNED, 10,000 ÷ LINE 12	LB	0.714	14
15	TOTAL AIR REQUIRED, LINE b ÷ 100 × VALUE FROM FIG. 4 OR TABLE 5 OR 6 = 1.7 × 7.575	LB	12.88	15
16	H_2O IN AIR, LINE 15 × LINE f = 12.88 × 0.0132	LB	.17	16
17	WET GAS, TOTAL, LINES (14 + 15 + 16)	LB	13.76	17
18	H_2O IN FUEL, (LINE 5 ÷ 100) × LINE 14 × 8.94 + (LINE 9 ÷ 100) × LINE 14; OR FROM TABLE 5	LB	0.36	18
19	H_2O IN FLUE GAS, TOTAL, LINE 16 + LINE 18	LB	0.53	19
20	H_2O IN FLUE GAS, TOTAL, IN PER CENT, (LINE 19 ÷ LINE 17) × 100	%	3.8	20
21	DRY GAS, TOTAL, LINE 17—LINE 19	LB	13.23	21

LINE	LOSSES PER 10,000 BTU FUEL INPUT	UNIT	VALUE	LINE
23	UNBURNED FUEL, 10,000 × LINE h ÷ 100	BTU	0	23
24	UNACCOUNTED, 10,000 × LINE i ÷ 100	BTU	250	24
25	RADIATION, 10,000 × LINE j ÷ 100	BTU	75	25
26	LATENT HEAT, H_2O IN FUEL, 1040 × LINE 18	BTU	374	26
27	SENSIBLE HEAT, FLUE GAS, LINE 17 × BTU FROM FIG. 2 @ LINE e AND LINE 20 = 13.76 × 67	BTU	922	27
28	TOTAL LOSSES, LINES (23 + 24 + 25 + 26 + 27)	BTU	1621	28
29	TOTAL LOSSES IN PER CENT, LINE (28 ÷ 10,000) × 100	%	16.21	29
30	EFFICIENCY, BY DIFFERENCE, 100—LINE 29	%	83.79	30

LINE	QUANTITIES PER 10,000 BTU FUEL INPUT COMBUSTION TEMPERATURE, ADIABATIC	UNIT	VALUE		LINE
32	HEAT INPUT FROM FUEL	BTU		10000	32
33	HEAT INPUT FROM AIR, LINES (15 + 16) × BTU FROM FIG. 3 @ LINE d TEMP	BTU		—	33
34	HEAT INPUT, TOTAL, LINES (32 + 33)	BTU		10000	34
35	LESS LATENT HEAT LOSS, H_2O IN FUEL, LINE 26	BTU		374	35
36	HEAT AVAILABLE, MAXIMUM	BTU		9625	36
37	LESS LINES (24 + 25) × 0.5*	BTU		163	37
38	HEAT AVAILABLE, LINE 36—LINE 37	BTU		9463	38
39	HEAT AVAILABLE PER LB OF FLUE GAS, LINE 38 ÷ LINE 17	BTU	688		39
40	ADIABATIC TEMPERATURE, FROM FIG. 2 FOR LINES 20 & 39	F	2500		40

* NOTE: IT IS CUSTOMARY TO REDUCE THE MAXIMUM HEAT AVAILABLE, LINE 36, BY FROM 1/3 TO 1/2 OF THE UNACCOUNTED PLUS RADIATION LOSSES, ON THE ASSUMPTION THAT A PORTION OF THESE LOSSES OCCURS IN THE COMBUSTION ZONE.

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COMBUSTION CALCULATIONS

BASED ON QUANTITIES PER 10,000 BTU FUEL INPUT

75000 #/HR LOAD
BASE CASE 1&2

LINE					
1	FUEL— COAL		CONDITIONS	DATE	a
2	ANALYSIS AS FIRED		BY TEST OR SPECIFICATION	8-23-95	
3	ULTIMATE, % BY WT	PROXIMATE, % BY WT	TOTAL AIR %	238	b
4	C 74.7	MOISTURE 2.9	AIR TEMPERATURE TO HEATER F	80	c
5	H_2 5.3	VOLATILE 34.7	AIR TEMPERATURE FROM HEATER F	—	d
6	S 0.7	FIXED CARBON 56.1	FLUE GAS TEMPERATURE LEAVING UNIT F	80	e
7	O_2 8.5	ASH 6.3	H_2O PER LB DRY AIR LB	0.0132	f
8	N_2 1.6				g
9	H_2O 2.9		UNBURNED FUEL LOSS %	0	h
10	ASH 6.3		UNACCOUNTED LOSS %	2.5	i
11			RADIATION LOSS (ABAI), FIG. 20, CHAPTER 7 %	1.00	j
12	BTU PER LB, AS FIRED, 14000				k

LINE		UNIT	VALUE	LINE
13	**QUANTITIES PER 10,000 BTU FUEL INPUT**			13
14	FUEL BURNED, 10,000 ÷ LINE 12	LB	0.714	14
15	TOTAL AIR REQUIRED, LINE b ÷ 100 × VALUE FROM FIG. 4 OR TABLE 5 OR 6 = 2.38×7.575	LB	18.03	15
16	H_2O IN AIR, LINE 15 × LINE f =	LB	0.24	16
17	WET GAS, TOTAL, LINES (14 + 15 + 16)	LB	18.98	17
18	H_2O IN FUEL, (LINE 5 ÷ 100) × LINE 14 × 8.94 + (LINE 9 ÷ 100) × LINE 14; OR FROM TABLE 5	LB	0.36	18
19	H_2O IN FLUE GAS, TOTAL, LINE 16 + LINE 18	LB	0.60	19
20	H_2O IN FLUE GAS, TOTAL, IN PER CENT, (LINE 19 ÷ LINE 17) × 100	%	3.16	20
21	DRY GAS, TOTAL, LINE 17—LINE 19	LB	18.38	21
22	**LOSSES PER 10,000 BTU FUEL INPUT**			22
23	UNBURNED FUEL, 10,000 × LINE h ÷ 100	BTU	0	23
24	UNACCOUNTED, 10,000 × LINE i ÷ 100	BTU	250	24
25	RADIATION, 10,000 × LINE j ÷ 100	BTU	100	25
26	LATENT HEAT, H_2O IN FUEL, 1040 × LINE 18	BTU	374	26
27	SENSIBLE HEAT, FLUE GAS, LINE 17 × BTU FROM FIG. 2 @ LINE e AND LINE 20 = 18.98×67	BTU	1272	27
28	TOTAL LOSSES, LINES (23 + 24 + 25 + 26 + 27)	BTU	1996	28
29	TOTAL LOSSES IN PER CENT, LINE (28 ÷ 10,000) × 100	%	19.96	29
30	EFFICIENCY, BY DIFFERENCE, 100—LINE 29	%	80.04	30
31	**QUANTITIES PER 10,000 BTU FUEL INPUT** COMBUSTION TEMPERATURE, ADIABATIC			31
32	HEAT INPUT FROM FUEL	BTU	10000	32
33	HEAT INPUT FROM AIR, LINES (15 + 16) × BTU FROM FIG. 3 @ LINE d TEMP	BTU	—	33
34	HEAT INPUT, TOTAL, LINES (32 + 33)	BTU	10000	34
35	LESS LATENT HEAT LOSS, H_2O IN FUEL, LINE 26	BTU	374	35
36	HEAT AVAILABLE, MAXIMUM	BTU	9626	36
37	LESS LINES (24 + 25) × 0.5*	BTU	175	37
38	HEAT AVAILABLE, LINE 36—LINE 37	BTU	9451	38
39	HEAT AVAILABLE PER LB OF FLUE GAS, LINE 38 ÷ LINE 17	BTU	500	39
40	ADIABATIC TEMPERATURE, FROM FIG. 2 FOR LINES 20 & 39	F	1900	40

* NOTE: IT IS CUSTOMARY TO REDUCE THE MAXIMUM HEAT AVAILABLE, LINE 36, BY FROM ⅓ TO ½ OF THE UNACCOUNTED PLUS RADIATION LOSSES, ON THE ASSUMPTION THAT A PORTION OF THESE LOSSES OCCURS IN THE COMBUSTION ZONE.

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LINE		LINE
	COMBUSTION CALCULATIONS BASED ON QUANTITIES PER 10,000 BTU FUEL INPUT 50 000 #/HR LOAD BASE CASE 1 & 2	

LINE			CONDITIONS BY TEST OR SPECIFICATION		DATE	
1	FUEL—					a
2	ANALYSIS AS FIRED				8-23-95	
3	ULTIMATE, % BY WT	PROXIMATE, % BY WT	TOTAL AIR	%	285	b
4	C	MOISTURE	AIR TEMPERATURE TO HEATER	F	80	c
5	H_2	VOLATILE	AIR TEMPERATURE FROM HEATER	F	—	d
6	S	FIXED CARBON	FLUE GAS TEMPERATURE LEAVING UNIT	F	375	e
7	O_2	ASH	H_2O PER LB DRY AIR	LB	0.0132	f
8	N_2					g
9	H_2O		UNBURNED FUEL LOSS	%	0	h
10	ASH		UNACCOUNTED LOSS	%	3.0	i
11			RADIATION LOSS (ABA1), FIG. 20, CHAPTER 7	%	1.5	j
12	BTU PER LB, AS FIRED,					k

LINE	QUANTITIES PER 10,000 BTU FUEL INPUT			LINE
13				13
14	FUEL BURNED, 10,000 ÷ LINE 12	LB	0.714	14
15	TOTAL AIR REQUIRED, LINE b ÷ 100 × VALUE FROM FIG. 4 OR TABLE 5 OR 6 = 2.85 × 7.575	LB	21.59	15
16	H_2O IN AIR, LINE 15 × LINE f =	LB	0.28	16
17	WET GAS, TOTAL, LINES (14 + 15 + 16)	LB	22.58	17
18	H_2O IN FUEL, (LINE 5 ÷ 100) × LINE 14 × 8.94 + (LINE 9 ÷ 100) × LINE 14; OR FROM TABLE 5	LB	0.36	18
19	H_2O IN FLUE GAS, TOTAL, LINE 16 + LINE 18	LB	0.64	19
20	H_2O IN FLUE GAS, TOTAL, IN PER CENT, (LINE 19 ÷ LINE 17) × 100	%	2.83	20
21	DRY GAS, TOTAL, LINE 17—LINE 19	LB	21.94	21

LINE	LOSSES PER 10,000 BTU FUEL INPUT			LINE
22				22
23	UNBURNED FUEL, 10,000 × LINE h ÷ 100	BTU	0	23
24	UNACCOUNTED, 10,000 × LINE i ÷ 100	BTU	300	24
25	RADIATION, 10,000 × LINE j ÷ 100	BTU	150	25
26	LATENT HEAT, H_2O IN FUEL, 1040 × LINE 18	BTU	374	26
27	SENSIBLE HEAT, FLUE GAS, LINE 17 × BTU FROM FIG. 2 @ LINE e AND LINE 20 = 22.58 × 67	BTU	1513	27
28	TOTAL LOSSES, LINES (23 + 24 + 25 + 26 + 27)	BTU	2337	28
29	TOTAL LOSSES IN PER CENT, LINE (28 ÷ 10,000) × 100	%	23.37	29
30	EFFICIENCY, BY DIFFERENCE, 100—LINE 29	%	76.63	30

LINE	QUANTITIES PER 10,000 BTU FUEL INPUT COMBUSTION TEMPERATURE, ADIABATIC					LINE
31						31
32	HEAT INPUT FROM FUEL			BTU	10000	32
33	HEAT INPUT FROM AIR, LINES (15 + 16) × BTU FROM FIG. 3 @ LINE d TEMP			BTU	—	33
34	HEAT INPUT, TOTAL, LINES (32 + 33)			BTU	10000	34
35	LESS LATENT HEAT LOSS, H_2O IN FUEL, LINE 26			BTU	374	35
36	HEAT AVAILABLE, MAXIMUM			BTU	9625	36
37	LESS LINES (24 + 25) × 0.5*			BTU	225	37
38	HEAT AVAILABLE, LINE 36—LINE 37			BTU	9400	38
39	HEAT AVAILABLE PER LB OF FLUE GAS, LINE 38 ÷ LINE 17	BTU	416			39
40	ADIABATIC TEMPERATURE, FROM FIG. 2 FOR LINES 20 & 39	F	1630			40

* NOTE: IT IS CUSTOMARY TO REDUCE THE MAXIMUM HEAT AVAILABLE, LINE 36, BY FROM 1/3 TO 1/2 OF THE UNACCOUNTED PLUS RADIATION LOSSES, ON THE ASSUMPTION THAT A PORTION OF THESE LOSSES OCCURS IN THE COMBUSTION ZONE.

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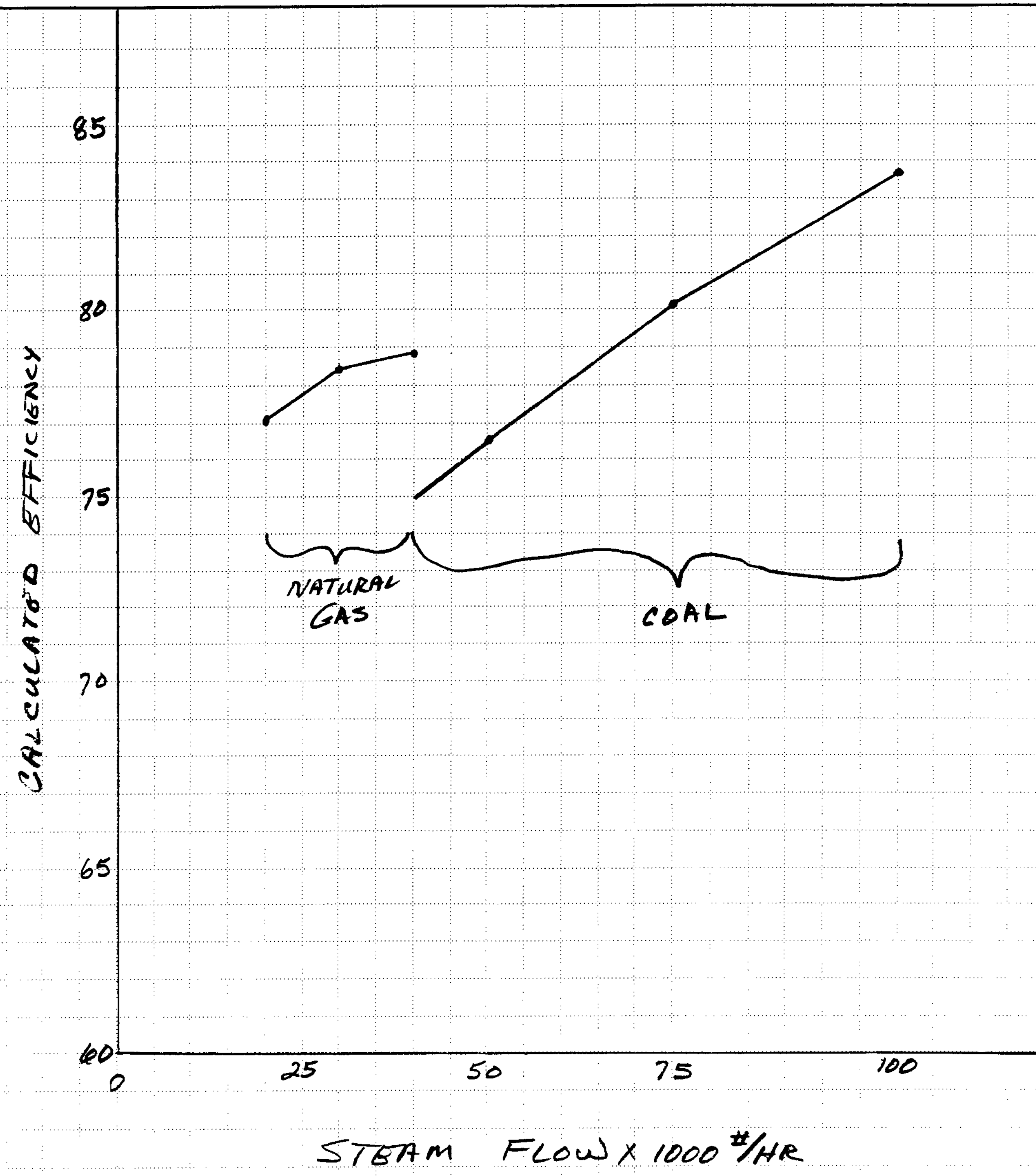
	Checked By:	Date:	Sheet No: 1 of 4

Calculations For: RETROFIT EXIST'G. BOILER W/ N.G. BURNER - CASE 3



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CASE 3

LINE	COMBUSTION CALCULATIONS BASED ON QUANTITIES PER 10,000 BTU FUEL INPUT	40,000 #/HR LOAD RETROFIT EXSTG.	LINE

LINE			CONDITIONS BY TEST OR SPECIFICATION		DATE 9-1-95	
1	FUEL— NATURAL GAS					a
2	ANALYSIS AS FIRED					
3	ULTIMATE, % BY WT	PROXIMATE, % BY WT	TOTAL AIR	%	107.5	b
4	C 69.3	MOISTURE	AIR TEMPERATURE TO HEATER	F	80	c
5	H_2 22.7	VOLATILE	AIR TEMPERATURE FROM HEATER	F	—	d
6	S —	FIXED CARBON	FLUE GAS TEMPERATURE LEAVING UNIT	F	375	e
7	O_2 —	ASH	H_2O PER LB DRY AIR	LB	0.0132	f
8	N_2 8.1					g
9	H_2O —		UNBURNED FUEL LOSS	%	0	h
10	ASH —		UNACCOUNTED LOSS	%	3.0	i
11			RADIATION LOSS (ABA1), FIG. 20, CHAPTER 7	%	2.0	j
12	BTU PER LB, AS FIRED, 21825					k

LINE	QUANTITIES PER 10,000 BTU FUEL INPUT			LINE
13				13
14	FUEL BURNED, 10,000 ÷ LINE 12	LB	0.458	14
15	TOTAL AIR REQUIRED, LINE b ÷ 100 × VALUE FROM FIG. 4 OR TABLE 5 OR 6 = 1.075 × 7.1	LB	7.633	15
16	H_2O IN AIR, LINE 15 × LINE f = 7.633 × 0.0132	LB	0.101	16
17	WET GAS, TOTAL, LINES (14 + 15 + 16)	LB	8.192	17
18	H_2O IN FUEL, (LINE 5 ÷ 100) × LINE 14 × 8.94 + (LINE 9 ÷ 100) × LINE 14; OR FROM TABLE 5	LB	0.929	18
19	H_2O IN FLUE GAS, TOTAL, LINE 16 + LINE 18	LB	1.030	19
20	H_2O IN FLUE GAS, TOTAL, IN PER CENT, (LINE 19 ÷ LINE 17) × 100	%	12.58	20
21	DRY GAS, TOTAL, LINE 17—LINE 19	LB	7.162	21
22	**LOSSES PER 10,000 BTU FUEL INPUT**			22
23	UNBURNED FUEL, 10,000 × LINE h ÷ 100	BTU	0	23
24	UNACCOUNTED, 10,000 × LINE i ÷ 100	BTU	300	24
25	RADIATION, 10,000 × LINE j ÷ 100	BTU	200	25
26	LATENT HEAT, H_2O IN FUEL, 1040 × LINE 18	BTU	966	26
27	SENSIBLE HEAT, FLUE GAS, LINE 17 × BTU FROM FIG. 2 @ LINE e AND LINE 20 = 8.192 × 78	BTU	640	27
28	TOTAL LOSSES, LINES (23 + 24 + 25 + 26 + 27)	BTU	2106	28
29	TOTAL LOSSES IN PER CENT, LINE (28 ÷ 10,000) × 100	%	21.06	29
30	EFFICIENCY, BY DIFFERENCE, 100—LINE 29	%	78.94	30
31	**QUANTITIES PER 10,000 BTU FUEL INPUT** COMBUSTION TEMPERATURE, ADIABATIC			31
32	HEAT INPUT FROM FUEL	BTU	10000	32
33	HEAT INPUT FROM AIR, LINES (15 + 16) × BTU FROM FIG. 3 @ LINE d TEMP	BTU	—	33
34	HEAT INPUT, TOTAL, LINES (32 + 33)	BTU	10000	34
35	LESS LATENT HEAT LOSS, H_2O IN FUEL, LINE 26	BTU	966	35
36	HEAT AVAILABLE, MAXIMUM	BTU	9034	36
37	LESS LINES (24 + 25) × 0.5*	BTU	250	37
38	HEAT AVAILABLE, LINE 36—LINE 37	BTU	8784	38
39	HEAT AVAILABLE PER LB OF FLUE GAS, LINE 38 ÷ LINE 17	BTU 1072		39
40	ADIABATIC TEMPERATURE, FROM FIG. 2 FOR LINES 20 & 39	F 3400		40

* NOTE: IT IS CUSTOMARY TO REDUCE THE MAXIMUM HEAT AVAILABLE, LINE 36, BY FROM ⅓ TO ½ OF THE UNACCOUNTED PLUS RADIATION LOSSES, ON THE ASSUMPTION THAT A PORTION OF THESE LOSSES OCCURS IN THE COMBUSTION ZONE.

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CASE 3

COMBUSTION CALCULATIONS

BASED ON QUANTITIES PER 10,000 BTU FUEL INPUT

30,000 #/HR LOAD

RETROFIT EXISTG.

LINE					LINE
1	FUEL— NATURAL GAS		CONDITIONS	DATE	a
2	ANALYSIS AS FIRED		BY TEST OR SPECIFICATION	9-1-95	
3	ULTIMATE, % BY WT	PROXIMATE, % BY WT	TOTAL AIR %	107.5	b
4	C 69.3	MOISTURE	AIR TEMPERATURE TO HEATER F	80	c
5	H_2 22.7	VOLATILE	AIR TEMPERATURE FROM HEATER F	—	d
6	S —	FIXED CARBON	FLUE GAS TEMPERATURE LEAVING UNIT F	80	e
7	O_2 —	ASH	H_2O PER LB DRY AIR LB	0.0132	f
8	N_2 8.1				g
9	H_2O —		UNBURNED FUEL LOSS %	0	h
10	ASH —		UNACCOUNTED LOSS %	3.0	i
11			RADIATION LOSS (ABAI), FIG. 20, CHAPTER 7 %	2.5	j
12	BTU PER LB, AS FIRED, 21825				k

LINE		UNIT			LINE
13	**QUANTITIES PER 10,000 BTU FUEL INPUT**				13
14	FUEL BURNED, 10,000 ÷ LINE 12	LB		0.458	14
15	TOTAL AIR REQUIRED, LINE b ÷ 100 × VALUE FROM FIG. 4 OR TABLE 5 OR 6 =	LB		7.633	15
16	H_2O IN AIR, LINE 15 × LINE f =	LB		0.101	16
17	WET GAS, TOTAL, LINES (14 + 15 + 16)	LB		8.192	17
18	H_2O IN FUEL, (LINE 5 ÷ 100) × LINE 14 × 8.94 + (LINE 9 ÷ 100) × LINE 14; OR FROM TABLE 5	LB		0.929	18
19	H_2O IN FLUE GAS, TOTAL, LINE 16 + LINE 18	LB		1.030	19
20	H_2O IN FLUE GAS, TOTAL, IN PER CENT, (LINE 19 ÷ LINE 17) × 100	%		12.58	20
21	DRY GAS, TOTAL, LINE 17—LINE 19	LB		7.162	21
22	**LOSSES PER 10,000 BTU FUEL INPUT**				22
23	UNBURNED FUEL, 10,000 × LINE h ÷ 100	BTU		0	23
24	UNACCOUNTED, 10,000 × LINE i ÷ 100	BTU		300	24
25	RADIATION, 10,000 × LINE j ÷ 100	BTU		250	25
26	LATENT HEAT, H_2O IN FUEL, 1040 × LINE 18	BTU		966	26
27	SENSIBLE HEAT, FLUE GAS, LINE 17 × BTU FROM FIG. 2 @ LINE e AND LINE 20 =	BTU		640	27
28	TOTAL LOSSES, LINES (23 + 24 + 25 + 26 + 27)	BTU		2156	28
29	TOTAL LOSSES IN PER CENT, LINE (28 ÷ 10,000) × 100	%		21.56	29
30	EFFICIENCY, BY DIFFERENCE, 100—LINE 29	%		78.44	30
31	**QUANTITIES PER 10,000 BTU FUEL INPUT** COMBUSTION TEMPERATURE, ADIABATIC				31
32	HEAT INPUT FROM FUEL	BTU		1000	32
33	HEAT INPUT FROM AIR, LINES (15 + 16) × BTU FROM FIG. 3 @ LINE d TEMP	BTU		—	33
34	HEAT INPUT, TOTAL, LINES (32 + 33)	BTU		1000	34
35	LESS LATENT HEAT LOSS, H_2O IN FUEL, LINE 26	BTU		966	35
36	HEAT AVAILABLE, MAXIMUM	BTU		9034	36
37	LESS LINES (24 + 25) × 0.5*	BTU		275	37
38	HEAT AVAILABLE, LINE 36—LINE 37	BTU		8759	38
39	HEAT AVAILABLE PER LB OF FLUE GAS, LINE 38 ÷ LINE 17	BTU	1069		39
40	ADIABATIC TEMPERATURE, FROM FIG. 2 FOR LINES 20 & 39	F	3400		40

* NOTE: IT IS CUSTOMARY TO REDUCE THE MAXIMUM HEAT AVAILABLE, LINE 36, BY FROM ½ TO ½ OF THE UNACCOUNTED PLUS RADIATION LOSSES, ON THE ASSUMPTION THAT A PORTION OF THESE LOSSES OCCURS IN THE COMBUSTION ZONE.

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CASE 3

LINE	COMBUSTION CALCULATIONS BASED ON QUANTITIES PER 10,000 BTU FUEL INPUT 20000 #/HR LOAD RETROFIT EXISTG.				LINE
1	FUEL— NATURAL GAS	CONDITIONS		DATE	a
2	ANALYSIS AS FIRED	BY TEST OR SPECIFICATION			
3	ULTIMATE, % BY WT / PROXIMATE, % BY WT	TOTAL AIR	%	110	b
4	C 69.3 / MOISTURE	AIR TEMPERATURE TO HEATER	F	80	c
5	H_2 22.7 / VOLATILE	AIR TEMPERATURE FROM HEATER	F	—	d
6	S — / FIXED CARBON	FLUE GAS TEMPERATURE LEAVING UNIT	F	375	e
7	O_2 — / ASH	H_2O PER LB DRY AIR	LB	0.0132	f
8	N_2 8.1				g
9	H_2O —	UNBURNED FUEL LOSS	%	0	h
10	ASH —	UNACCOUNTED LOSS	%	3.0	i
11		RADIATION LOSS (ABA1), FIG. 20, CHAPTER 7	%	3.8	j
12	BTU PER LB, AS FIRED, 21825				k

LINE	QUANTITIES PER 10,000 BTU FUEL INPUT			LINE
14	FUEL BURNED, 10,000 ÷ LINE 12	LB	0.458	14
15	TOTAL AIR REQUIRED, LINE b ÷ 100 × VALUE FROM FIG. 4 OR TABLE 5 OR 6 =	LB	7.811	15
16	H_2O IN AIR, LINE 15 × LINE f =	LB	0.103	16
17	WET GAS, TOTAL, LINES (14 + 15 + 16)	LB	8.372	17
18	H_2O IN FUEL, (LINE 5 ÷ 100) × LINE 14 × 8.94 + (LINE 9 ÷ 100) × LINE 14; OR FROM TABLE 5	LB	0.929	18
19	H_2O IN FLUE GAS, TOTAL, LINE 16 + LINE 18	LB	1.032	19
20	H_2O IN FLUE GAS, TOTAL, IN PER CENT, (LINE 19 ÷ LINE 17) × 100	%	12.33	20
21	DRY GAS, TOTAL, LINE 17—LINE 19	LB	7.340	21
22	**LOSSES PER 10,000 BTU FUEL INPUT**			22
23	UNBURNED FUEL, 10,000 × LINE h ÷ 100	BTU	0	23
24	UNACCOUNTED, 10,000 × LINE i ÷ 100	BTU	300	24
25	RADIATION, 10,000 × LINE j ÷ 100	BTU	380	25
26	LATENT HEAT, H_2O IN FUEL, 1040 × LINE 18	BTU	966	26
27	SENSIBLE HEAT, FLUE GAS, LINE 17 × BTU FROM FIG. 2 @ LINE e AND LINE 20 = 8.372 × 78	BTU	653	27
28	TOTAL LOSSES, LINES (23 + 24 + 25 + 26 + 27)	BTU	2299	28
29	TOTAL LOSSES IN PER CENT, LINE (28 ÷ 10,000) × 100	%	22.99	29
30	EFFICIENCY, BY DIFFERENCE, 100—LINE 29	%	77.01	30
31	**QUANTITIES PER 10,000 BTU FUEL INPUT** COMBUSTION TEMPERATURE, ADIABATIC			31
32	HEAT INPUT FROM FUEL	BTU	10000	32
33	HEAT INPUT FROM AIR, LINES (15 + 16) × BTU FROM FIG. 3 @ LINE d TEMP	BTU	—	33
34	HEAT INPUT, TOTAL, LINES (32 + 33)	BTU	10000	34
35	LESS LATENT HEAT LOSS, H_2O IN FUEL, LINE 26	BTU	966	35
36	HEAT AVAILABLE, MAXIMUM	BTU	9034	36
37	LESS LINES (24 + 25) × 0.5*	BTU	340	37
38	HEAT AVAILABLE, LINE 36—LINE 37	BTU	8694	38
39	HEAT AVAILABLE PER LB OF FLUE GAS, LINE 38 ÷ LINE 17	BTU	1038	39
40	ADIABATIC TEMPERATURE, FROM FIG. 2 FOR LINES 20 & 39	F	3590	40

* NOTE: IT IS CUSTOMARY TO REDUCE THE MAXIMUM HEAT AVAILABLE, LINE 36, BY FROM ⅓ TO ½ OF THE UNACCOUNTED PLUS RADIATION LOSSES, ON THE ASSUMPTION THAT A PORTION OF THESE LOSSES OCCURS IN THE COMBUSTION ZONE.

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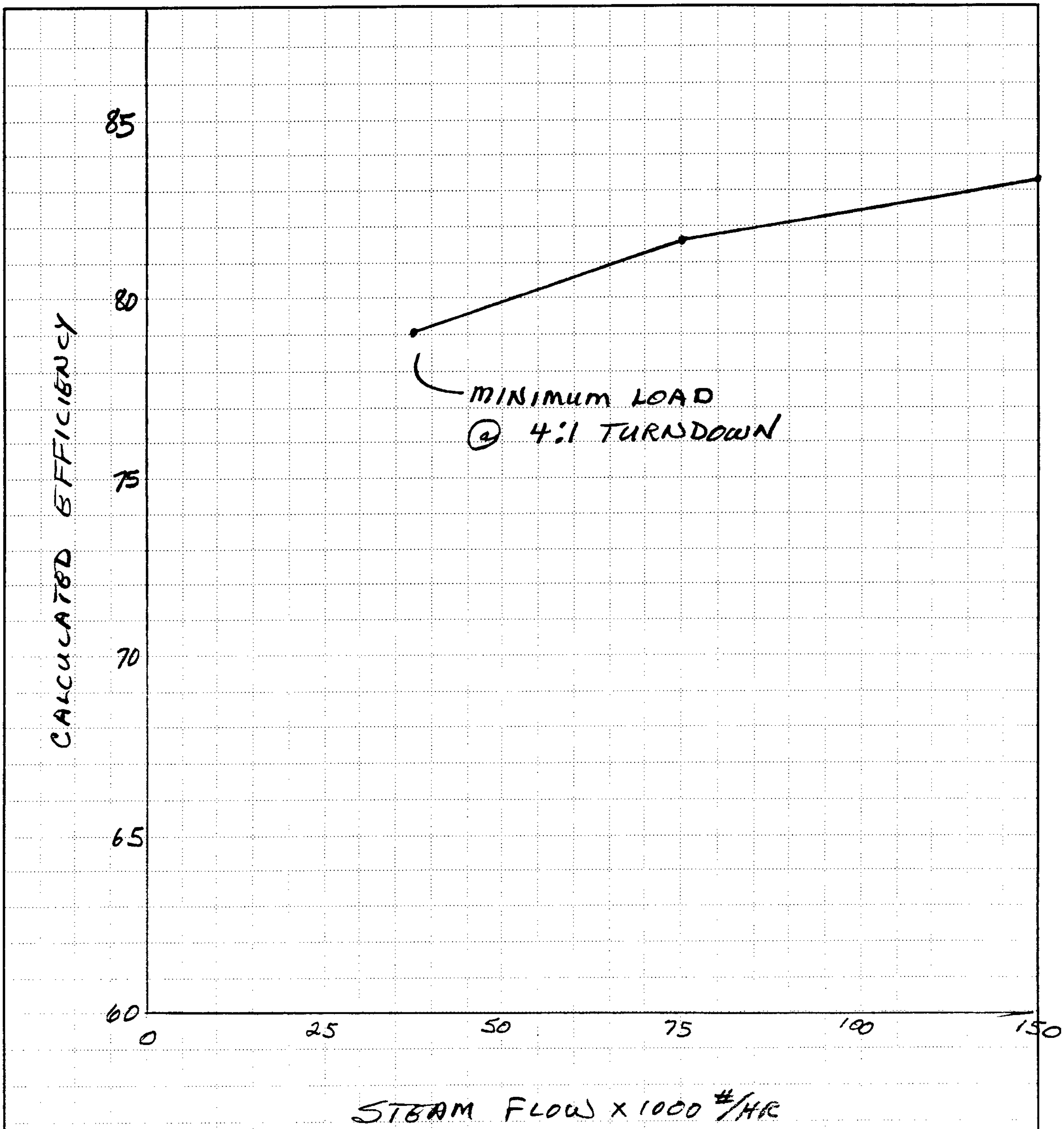
	Checked By:	Date:	Sheet No: 1 of 4

Calculations For: BOILERS FROM VAAP - CASE 4 & 5



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CASE 4 & 5

COMBUSTION CALCULATIONS

BASED ON QUANTITIES PER 10,000 BTU FUEL INPUT

150,000 #/HR
LOAD: 340 PSIG.
433°F SATURATED
VAAP BOILERS

LINE				
1	FUEL— NATURAL GAS			
2	ANALYSIS AS FIRED			
3	ULTIMATE, % BY WT		PROXIMATE, % BY WT	
4	C	69.3	MOISTURE	
5	H_2	22.7	VOLATILE	
6	S	—	FIXED CARBON	
7	O_2	—	ASH	
8	N_2	8.1		
9	H_2O	—		
10	ASH	—		
11				
12	BTU PER LB, AS FIRED, 21825			

CONDITIONS BY TEST OR SPECIFICATION		DATE 9-5-95	LINE
			a
TOTAL AIR	%	107.5	b
AIR TEMPERATURE TO HEATER	F	80	c
AIR TEMPERATURE FROM HEATER	F	—	d
FLUE GAS TEMPERATURE LEAVING UNIT	F	300	e
H_2O PER LB DRY AIR	LB	0.0132	f
			g
UNBURNED FUEL LOSS	%	0	h
UNACCOUNTED LOSS	%	1.5	i
RADIATION LOSS (ABA1), FIG. 20, CHAPTER 7	%	0.65	j
			k

LINE				LINE
13	**QUANTITIES PER 10,000 BTU FUEL INPUT**			13
14	FUEL BURNED, 10,000 ÷ LINE 12	LB	0.458	14
15	TOTAL AIR REQUIRED, LINE b ÷ 100 × VALUE FROM FIG. 4 OR TABLE 5 OR 6 = 1.075 × 7.1	LB	7.633	15
16	H_2O IN AIR, LINE 15 × LINE f =	LB	0.101	16
17	WET GAS, TOTAL, LINES (14 + 15 + 16)	LB	8.192	17
18	H_2O IN FUEL, (LINE 5 ÷ 100) × LINE 14 × 8.94 + (LINE 9 ÷ 100) × LINE 14; OR FROM TABLE 5	LB	0.929	18
19	H_2O IN FLUE GAS, TOTAL, LINE 16 + LINE 18	LB	1.030	19
20	H_2O IN FLUE GAS, TOTAL, IN PER CENT, (LINE 19 ÷ LINE 17) × 100	%	12.58	20
21	DRY GAS, TOTAL, LINE 17—LINE 19	LB	7.162	21
22	**LOSSES PER 10,000 BTU FUEL INPUT**			22
23	UNBURNED FUEL, 10,000 × LINE h ÷ 100	BTU	0	23
24	UNACCOUNTED, 10,000 × LINE i ÷ 100	BTU	150	24
25	RADIATION, 10,000 × LINE j ÷ 100	BTU	65	25
26	LATENT HEAT, H_2O IN FUEL, 1040 × LINE 18	BTU	966	26
27	SENSIBLE HEAT, FLUE GAS, LINE 17 × BTU FROM FIG. 2 @ LINE e AND LINE 20 = 8.192 × 60	BTU	492	27
28	TOTAL LOSSES, LINES (23 + 24 + 25 + 26 + 27)	BTU	1673	28
29	TOTAL LOSSES IN PER CENT, LINE (28 ÷ 10,000) × 100	%	16.73	29
30	EFFICIENCY, BY DIFFERENCE, 100—LINE 29	%	83.27	30
31	**QUANTITIES PER 10,000 BTU FUEL INPUT** COMBUSTION TEMPERATURE, ADIABATIC			31
32	HEAT INPUT FROM FUEL	BTU	10000	32
33	HEAT INPUT FROM AIR, LINES (15 + 16) × BTU FROM FIG. 3 @ LINE d TEMP	BTU	—	33
34	HEAT INPUT, TOTAL, LINES (32 + 33)	BTU	10000	34
35	LESS LATENT HEAT LOSS, H_2O IN FUEL, LINE 26	BTU	966	35
36	HEAT AVAILABLE, MAXIMUM	BTU	9034	36
37	LESS LINES (24 + 25) × 0.5*	BTU	108	37
38	HEAT AVAILABLE, LINE 36—LINE 37	BTU	8926	38
39	HEAT AVAILABLE PER LB OF FLUE GAS, LINE 38 ÷ LINE 17	BTU	1090	39
40	ADIABATIC TEMPERATURE, FROM FIG. 2 FOR LINES 20 & 39	F	3470	40

* NOTE: IT IS CUSTOMARY TO REDUCE THE MAXIMUM HEAT AVAILABLE, LINE 36, BY FROM ⅓ TO ½ OF THE UNACCOUNTED PLUS RADIATION LOSSES, ON THE ASSUMPTION THAT A PORTION OF THESE LOSSES OCCURS IN THE COMBUSTION ZONE.

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CASE 4 5

COMBUSTION CALCULATIONS

BASED ON QUANTITIES PER 10,000 BTU FUEL INPUT

75000 #/HR
LOAD; 340 PSIG;
433 °F SATURATED
VAAP BOILERS

LINE				LINE
1	FUEL— NATURAL GAS	CONDITIONS	DATE	a
2	ANALYSIS AS FIRED	BY TEST OR SPECIFICATION	9-5-95	
3	ULTIMATE, % BY WT / PROXIMATE, % BY WT	TOTAL AIR %	107.5	b
4	C 69.3 / MOISTURE	AIR TEMPERATURE TO HEATER F	80	c
5	H_2 22.7 / VOLATILE	AIR TEMPERATURE FROM HEATER F	—	d
6	S — / FIXED CARBON	FLUE GAS TEMPERATURE LEAVING UNIT F	300	e
7	O_2 — / ASH	H_2O PER LB DRY AIR LB	0.0132	f
8	N_2 8.1			g
9	H_2O —	UNBURNED FUEL LOSS %	0	h
10	ASH —	UNACCOUNTED LOSS %	1.5	i
11		RADIATION LOSS (ABAI), FIG. 20, CHAPTER 7 %	1.2	j
12	BTU PER LB, AS FIRED, 21825			k

LINE	QUANTITIES PER 10,000 BTU FUEL INPUT	UNIT	VALUE	LINE
13				13
14	FUEL BURNED, 10,000 ÷ LINE 12	LB	0.458	14
15	TOTAL AIR REQUIRED, LINE b ÷ 100 × VALUE FROM FIG. 4 OR TABLE 5 OR 6 = 1.075×7.1	LB	7.633	15
16	H_2O IN AIR, LINE 15 × LINE f =	LB	0.101	16
17	WET GAS, TOTAL, LINES (14 + 15 + 16)	LB	8.192	17
18	H_2O IN FUEL, (LINE 5 ÷ 100) × LINE 14 × 8.94 + (LINE 9 ÷ 100) × LINE 14; OR FROM TABLE 5	LB	0.929	18
19	H_2O IN FLUE GAS, TOTAL, LINE 16 + LINE 18	LB	1.030	19
20	H_2O IN FLUE GAS, TOTAL, IN PER CENT, (LINE 19 ÷ LINE 17) × 100	%	12.58	20
21	DRY GAS, TOTAL, LINE 17—LINE 19	LB	7.162	21

LINE	LOSSES PER 10,000 BTU FUEL INPUT	UNIT	VALUE	LINE
22				22
23	UNBURNED FUEL, 10,000 × LINE h ÷ 100	BTU	0	23
24	UNACCOUNTED, 10,000 × LINE i ÷ 100	BTU	150	24
25	RADIATION, 10,000 × LINE j ÷ 100	BTU	120	25
26	LATENT HEAT, H_2O IN FUEL, 1040 × LINE 18	BTU	966	26
27	SENSIBLE HEAT, FLUE GAS, LINE 17 × BTU FROM FIG. 2 @ LINE e AND LINE 20 =	BTU	492	27
28	TOTAL LOSSES, LINES (23 + 24 + 25 + 26 + 27)	BTU	1728	28
29	TOTAL LOSSES IN PER CENT, LINE (28 ÷ 10,000) × 100	%	17.28	29
30	EFFICIENCY, BY DIFFERENCE, 100—LINE 29	%	82.72	30

LINE	QUANTITIES PER 10,000 BTU FUEL INPUT COMBUSTION TEMPERATURE, ADIABATIC	UNIT	VALUE		LINE
31					31
32	HEAT INPUT FROM FUEL	BTU		10000	32
33	HEAT INPUT FROM AIR, LINES (15 + 16) × BTU FROM FIG. 3 @ LINE d TEMP	BTU		—	33
34	HEAT INPUT, TOTAL, LINES (32 + 33)	BTU		10000	34
35	LESS LATENT HEAT LOSS, H_2O IN FUEL, LINE 26	BTU		966	35
36	HEAT AVAILABLE, MAXIMUM	BTU		9034	36
37	LESS LINES (24 + 25) × 0.5*	BTU		135	37
38	HEAT AVAILABLE, LINE 36—LINE 37	BTU		8899	38
39	HEAT AVAILABLE PER LB OF FLUE GAS, LINE 38 ÷ LINE 17	BTU	1086		39
40	ADIABATIC TEMPERATURE, FROM FIG. 2 FOR LINES 20 & 39	F	3470		40

* NOTE: IT IS CUSTOMARY TO REDUCE THE MAXIMUM HEAT AVAILABLE, LINE 36, BY FROM ⅓ TO ½ OF THE UNACCOUNTED PLUS RADIATION LOSSES, ON THE ASSUMPTION THAT A PORTION OF THESE LOSSES OCCURS IN THE COMBUSTION ZONE.

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CASE 4&5

LINE	COMBUSTION CALCULATIONS BASED ON QUANTITIES PER 10,000 BTU FUEL INPUT	37500 #/HR LOAD: 340 PSIG; 433°F SATURATED VAAP BOILERS	LINE

LINE	FUEL		CONDITIONS BY TEST OR SPECIFICATION		DATE 9-5-95	LINE
1	FUEL— NATURAL GAS					a
2	ANALYSIS AS FIRED					
3	ULTIMATE, % BY WT	PROXIMATE, % BY WT	TOTAL AIR	%	110.0	b
4	C 67.3	MOISTURE	AIR TEMPERATURE TO HEATER	F	80	c
5	H_2 22.7	VOLATILE	AIR TEMPERATURE FROM HEATER	F	—	d
6	S —	FIXED CARBON	FLUE GAS TEMPERATURE LEAVING UNIT	F	300	e
7	O_2 —	ASH	H_2O PER LB DRY AIR	LB	0.0132	f
8	N_2 8.1					g
9	H_2O —		UNBURNED FUEL LOSS	%	0	h
10	ASH —		UNACCOUNTED LOSS	%	1.5	i
11			RADIATION LOSS (ABA1), FIG. 20, CHAPTER 7	%	3.3	j
12	BTU PER LB, AS FIRED, 21825					k

LINE	QUANTITIES PER 10,000 BTU FUEL INPUT			LINE
14	FUEL BURNED, 10,000 ÷ LINE 12	LB	0.458	14
15	TOTAL AIR REQUIRED, LINE b ÷ 100 × VALUE FROM FIG. 4 OR TABLE 5 OR 6 = 1.1 × 7.1	LB	7.810	15
16	H_2O IN AIR, LINE 15 × LINE f =	LB	0.103	16
17	WET GAS, TOTAL, LINES (14 + 15 + 16)	LB	8.371	17
18	H_2O IN FUEL, (LINE 5 ÷ 100) × LINE 14 × 8.94 + (LINE 9 ÷ 100) × LINE 14; OR FROM TABLE 5	LB	0.929	18
19	H_2O IN FLUE GAS, TOTAL, LINE 16 + LINE 18	LB	1.032	19
20	H_2O IN FLUE GAS, TOTAL, IN PER CENT, (LINE 19 ÷ LINE 17) × 100	%	12.33	20
21	DRY GAS, TOTAL, LINE 17—LINE 19	LB	7.339	21

LINE	LOSSES PER 10,000 BTU FUEL INPUT			LINE
23	UNBURNED FUEL, 10,000 × LINE h ÷ 100	BTU	0	23
24	UNACCOUNTED, 10,000 × LINE i ÷ 100	BTU	150	24
25	RADIATION, 10,000 × LINE j ÷ 100	BTU	330	25
26	LATENT HEAT, H_2O IN FUEL, 1040 × LINE 18	BTU	966	26
27	SENSIBLE HEAT, FLUE GAS, LINE 17 × BTU FROM FIG. 2 @ LINE e AND LINE 20 = 8.371 × 78	BTU	653	27
28	TOTAL LOSSES, LINES (23 + 24 + 25 + 26 + 27)	BTU	2099	28
29	TOTAL LOSSES IN PER CENT, LINE (28 ÷ 10,000) × 100	%	20.99	29
30	EFFICIENCY, BY DIFFERENCE, 100—LINE 29	%	79.01	30

LINE	QUANTITIES PER 10,000 BTU FUEL INPUT COMBUSTION TEMPERATURE, ADIABATIC					LINE
32	HEAT INPUT FROM FUEL			BTU	10000	32
33	HEAT INPUT FROM AIR, LINES (15 + 16) × BTU FROM FIG. 3 @ LINE d TEMP			BTU	—	33
34	HEAT INPUT, TOTAL, LINES (32 + 33)			BTU	10000	34
35	LESS LATENT HEAT LOSS, H_2O IN FUEL, LINE 26			BTU	966	35
36	HEAT AVAILABLE, MAXIMUM			BTU	9034	36
37	LESS LINES (24 + 25) × 0.5*			BTU	220	37
38	HEAT AVAILABLE, LINE 36—LINE 37			BTU	8814	38
39	HEAT AVAILABLE PER LB OF FLUE GAS, LINE 38 ÷ LINE 17	BTU	1053			39
40	ADIABATIC TEMPERATURE, FROM FIG. 2 FOR LINES 20 & 39	F	3350			40

* NOTE: IT IS CUSTOMARY TO REDUCE THE MAXIMUM HEAT AVAILABLE, LINE 36, BY FROM ⅓ TO ½ OF THE UNACCOUNTED PLUS RADIATION LOSSES, ON THE ASSUMPTION THAT A PORTION OF THESE LOSSES OCCURS IN THE COMBUSTION ZONE.

Heat Losses in Steam Generating Units

(Based on ASME Test Form for Abbreviated Efficiency Test)

Dry refuse per lb of as-fired fuel, lb/lb

$$= \frac{\%\ \text{ash in as-fired fuel}}{100 - \%\ \text{combustible in refuse sample}}$$

Carbon burned per lb of as-fired fuel, lb/lb

$$= \frac{\%\ \text{carbon by weight in fuel sample}}{100} - \left(\frac{\text{dry refuse per lb fuel} \times \text{Btu per lb of refuse}}{14{,}500}\right)$$

Note: If flue dust and ash pit refuse differ materially in combustible content they should be estimated separately.

Dry gas per lb of as-fired fuel burned, lb/lb

$$= \frac{11\ CO_2 + 8\ O_2 + 7\ (N_2 + CO)}{3\ (CO_2 + CO)} \times (\text{lb carbon burned per lb as-fired fuel} + 3/8\ S)$$

where: CO_2, O_2 and CO are the per cents by volume of carbon dioxide, oxygen and carbon monoxide, respectively in the flue gas; N_2 is the per cent of volume of nitrogen, by difference, in the flue gas. S is the pound of sulfur per lb of as-fired fuel from the fuel analysis, or $\frac{\%\ \text{sulfur in fuel}}{100}$

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1. Heat loss due to dry gas

= lb dry gas per lb as-fired fuel burned $\times$ .24 (tg − ta)

where: .24 = specific heat of gas
tg = temperature of gas leaving unit, F
ta = temperature of air entering unit, F

2. Heat loss due to moisture in fuel

$$= \frac{H_2O}{100} \times (\text{enthalpy of vapor at 1 PSIA and tg} - \text{enthalpy of liquid at ta})$$

where: H_2O = % moisture in fuel

3. Heat loss due to hydrogen in fuel

$$= \frac{9\ H_2}{100} \times (\text{enthalpy of vapor at 1 PSIA and tg} - \text{enthalpy of liquid at ta})$$

where: H_2 = % hydrogen in fuel
tg = temperature of gas leaving unit, F
ta = temperature of air entering unit, F

4. Heat loss due to CO in flue gas

$$= \frac{CO}{CO_2 \times CO} \times 10{,}160 \times \text{lb carbon burned per lb as-fired fuel}$$

where: CO and CO_2 are per cent by volume of carbon monoxide and carbon diox in flue gas
10,160 = Btu generated burning 1 lb of CO to CO_2

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Heat loss due to unburned combustible

= dry refuse (ash pit + fly-ash) per lb as-fired fuel × Btu per lb in refuse (weighted average)

Calculations for each of the above five losses will give the Btu per lb for each loss. To determine the per cent loss in efficiency, which is the per cent of heating value of as-fired fuel:

$$\frac{\text{Btu in loss}}{\text{Btu per lb as-fired fuel}} \times 100 = \%\ \text{loss}$$

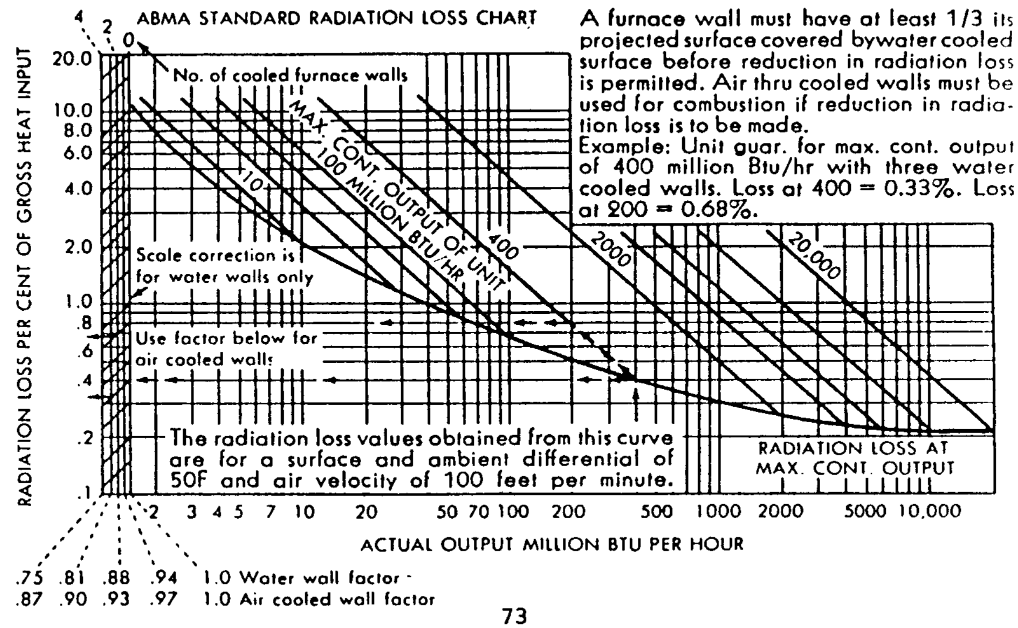
Heat loss due to radiation

The per cent loss in efficiency due to radiation may be obtained from the ABMA Standard Radiation Loss Chart on page 73.

Unaccounted for losses

These losses include relatively minor losses such as sensible heat in ash or slag, radiation to ash pit, moisture in air, heat pickup in cooling water, etc., generally not measured because the effort is not justifiable. A previously agreed upon amount can be assigned for these losses, if they are not measured.

Unit efficiency as determined by heat loss measurement then becomes the total of the above percentage efficiency losses subtracted from 100%.



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FORMULAS

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REFERENCE

Chapter 4. Principles of Combustion

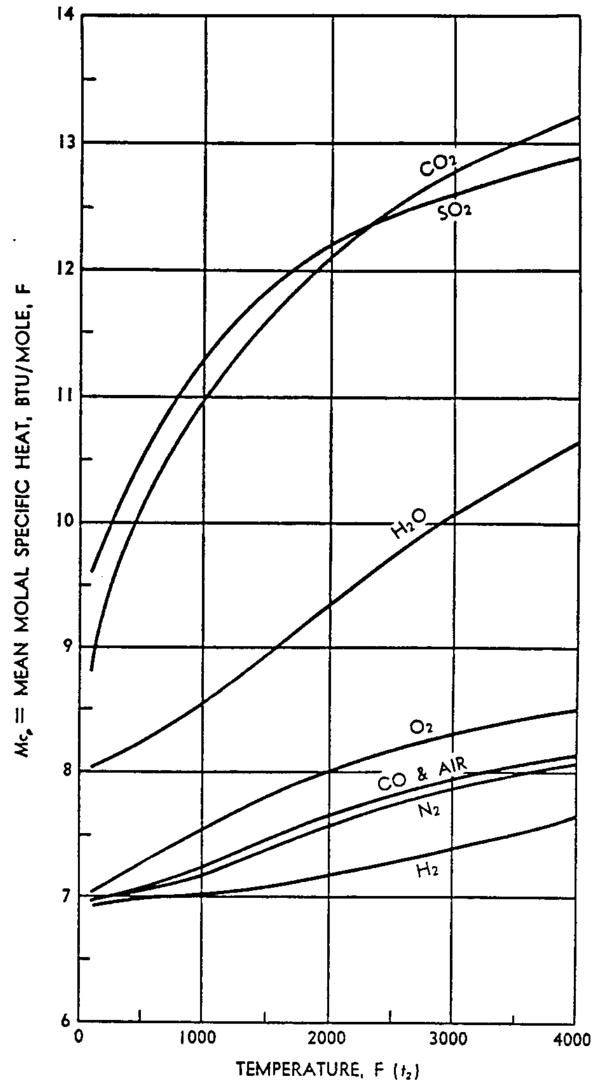

Fig. 1. *Mean molal specific heat of gases between final temperature (t_2) and 80 F at std atmospheric pressure*

TABLE 5

Theoretical Air, Fuel, and Resulting Moisture Per 10,000 Btu As Fired

Fuel	Theoretical Air,* lb/10kB	Fuel, lb/10kB	Moisture, lb/10kB
Fuel oil	7.46	0.544	0.51
Natural gas	7.10	0.496	0.93
Coal (prox anal.)	See Fig. 4	—	—
Coal (ult anal.)	See Table 6	—	—

*Dry air. To obtain wt of wet air required, moisture in air at standard conditions (0.0132 lb per lb dry air @ 60% relative humidity and 80 F dry bulb) must be added.

TABLE 6

Formula for Calculating Theoretical Air*

In lb per 10,000 Btu of Fuel as Fired
Ultimate Analysis of Fuel on As-Fired Basis,
Per Cent by Weight

C = Carbon
H_2 = Hydrogen
O_2 = Oxygen
S = Sulfur
Btu/lb = Heat value of fuel

$$\text{Theoretical Air,}\dagger\ \text{lb (per 10kB)} = 144 \times \frac{8C + 24\left\{H_2 - \frac{O_2}{8}\right\} + 3S}{\text{Btu/lb}}$$

*This formula should be used only when the exact ultimate analysis and the correct heating value are given for the fuel.
†Dry air. To obtain wt of wet air required, moisture in air at standard conditions (0.0132 lb per lb dry air @ 60% relative humidity and 80 F dry bulb) must be added.

95046-00
COMBUSTION
CALCULATIONS
REFERENCE

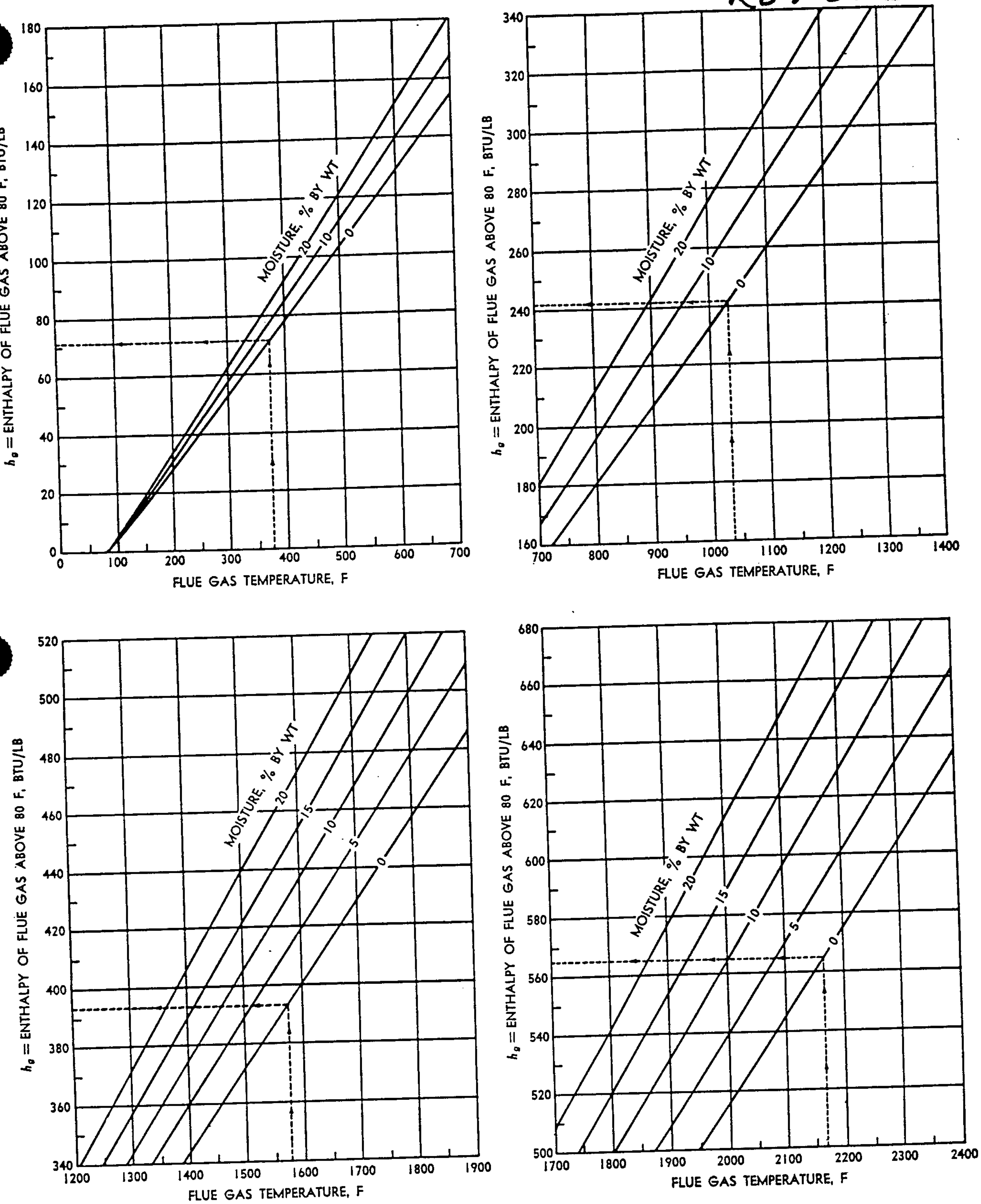

Fig. 2. *Enthalpy of flue gas above 80 F at 30 in. Hg, Btu per lb*

4-A2

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REFERENCE

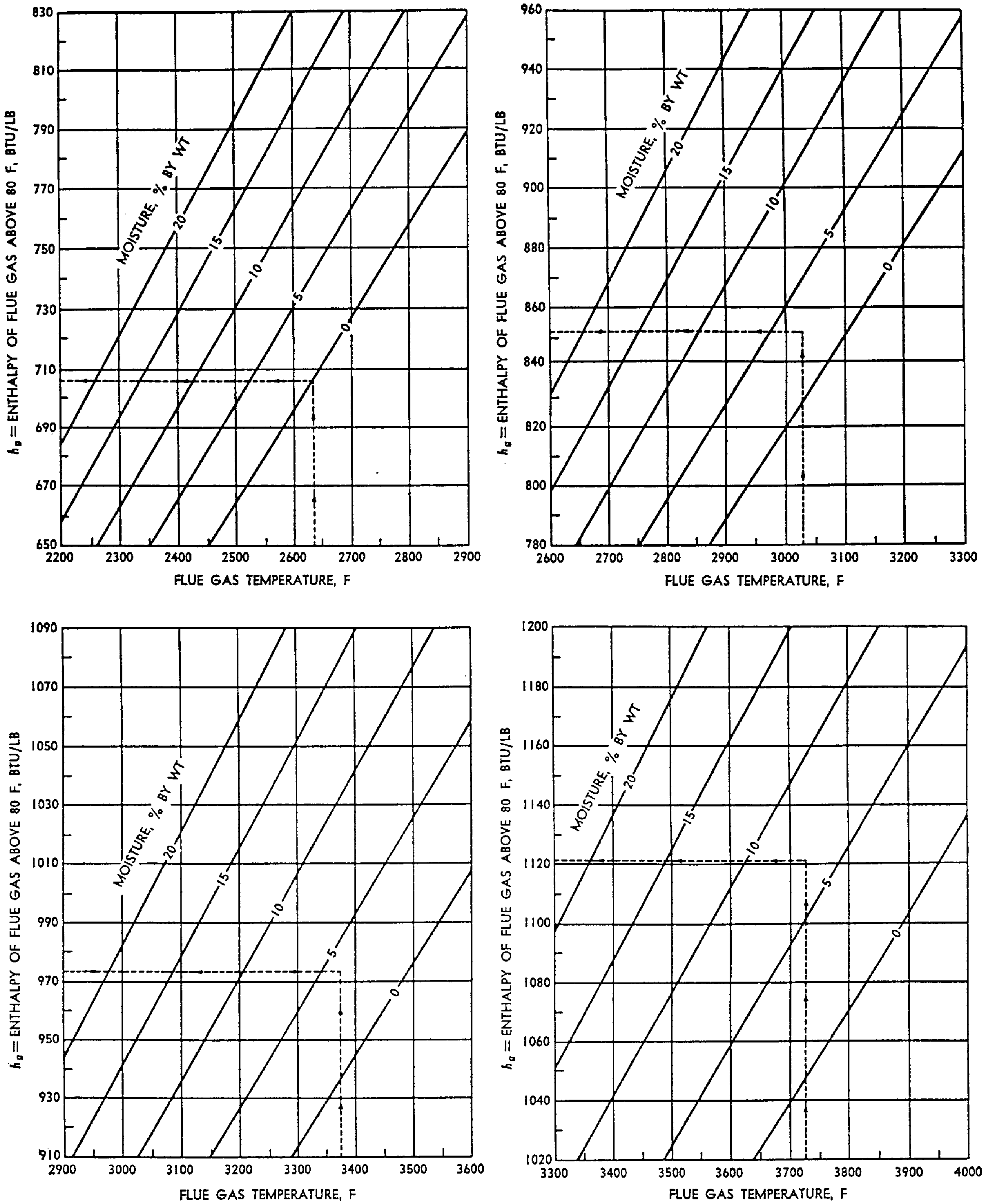

Fig. 2. (Cont'd) *Enthalpy of flue gas above 80 F at 30 in. Hg, Btu per lb*

4-A3

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COMBUSTION
CALCULATIONS
REFERENCE

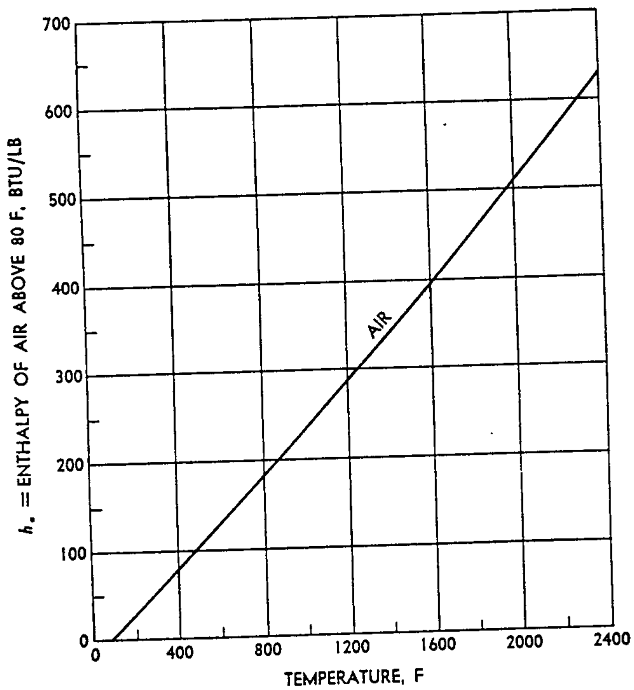

Fig. 3. *Enthalpy (above 80 F) of air (0.987 lb dry air plus 0.013 lb water vapor per lb mixture) at 30 in. Hg, Btu per lb*

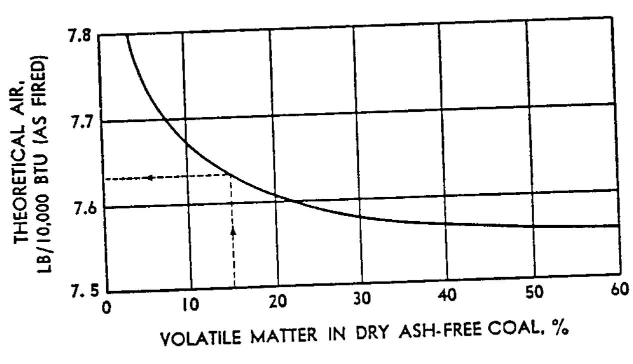

Fig. 4. *Theoretical air in lb per 10,000 Btu heat value of coal with a range of volatile*

4-A4

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Calculations For: EXCESS AIR/TOTAL AIR - STOKER OPER. COAL BLR

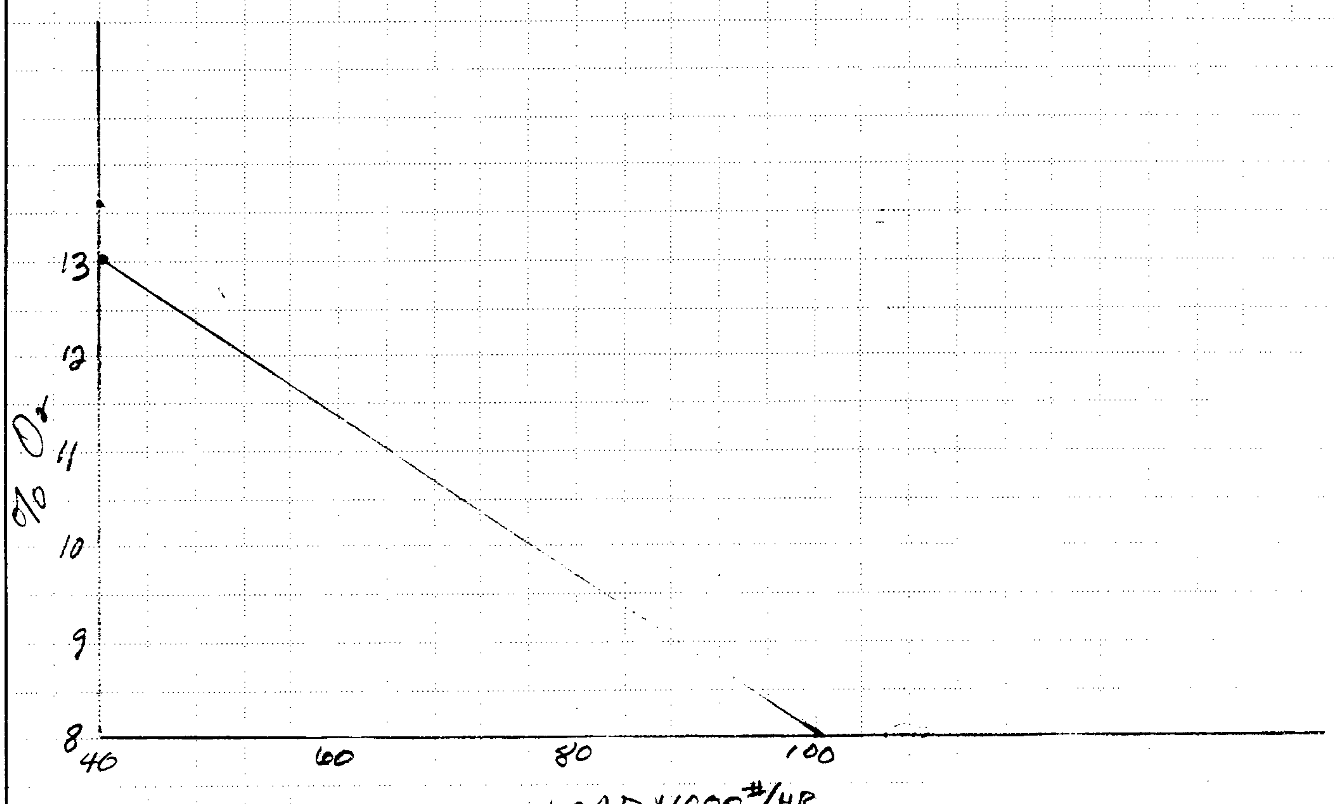
ASSUMPTIONS:

1) O_2 IN FLUE GAS = 8% @ FULL LOAD
2) O_2 IN FLUE GAS = 13% @ MINIMUM LOAD
3) COMBUSTION IS COMPLETE (CO = 0)

$$\% \text{ EXCESS AIR} = 100\left[\frac{O_2 - CO/2}{0.246 N_2 - (O_2 - CO/2)}\right]$$

$$\text{FULL LOAD: } \% = 100\left(\frac{.08}{0.246(.79) - .08}\right) = 70.0$$

$$\text{MIN. LOAD: } \% = 100\left(\frac{.13}{0.246(.79) - .13}\right) = 202.1$$



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		Checked By:	Date:	Sheet No: 1 of 6

Calculations For: BLDG. 7-A AUX BURNER RETROFIT @ HT. RECOV. BOILERS

CRACKING FURNACE BURNER DATA:

1750 MBH RATED CAP.
360 SCFM COMBUSTION AIR

$$N.G. \ \#/HR = \frac{1750000 \ B/H}{21825 \ B/\#} = 80.2 \ \#/H$$

$$AIR \ \#/H = 360 \ FT^3/m \left(60 \ m/H\right)\left(0.075 \ \#/FT^3\right) = 1620 \ \#/H$$

$$THEOR. \ AIR = \frac{1750000 \left(7.10 \ \#/10^4 B + 0.093 \ \#H_2O/10^4 B\right)}{10^4} = 1260 \ \#/HR$$

$$EXCESS \ AIR = \frac{1620}{1260} = 128.6\%$$

FLUE GAS FLOW = 1620 + 80 = 1700 #/H @ 625°F

FIND N.G. AND PRI. AIR RQD. TO GIVE FLUE GAS TEMP. OF 1250°F @ 110% EX. AIR.

Δ BTU FOR FURNACE GAS = 1700 #/H (325 B/# - 180 B/#)(# FURN)

= 3,944,000 BTUH

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PDL	8·30·95	95046-00
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Calculations For: BLDG 7-A AUX BRNR RETROFIT @ HT. REC. BOILERS

BOILER GAS SIDE FLOW $= (1700\ \#/HR)(16) = 27200\ \#/H$

APPROX. FLUE GAS SP. VOL. @ 625°F $= 30\ FT^3/\#$

GAS CFM $= \dfrac{27200\ (30)}{60\ MIN/H} = 13600$

FIRE TUBE MAX. VEL. $= \dfrac{13600\ FT^3/MIN}{(700\ TUBES)(0.0171\ FT^2/TUB)} = 1136\ F/MIN$

AIR AVAILABLE IN FURNACE EXIT GAS FOR AUX. BURNER:

AIR $= (1620 - 1260)(16) = 5760\ \#/HR.$

BURNER RATING @ 110% EXCESS AIR:

RATING $= \left(\dfrac{5760}{1.1}\right) \dfrac{10^4}{(7.10 + 0.093)(10^3)} = 7280$ MBH

TRY 7000 MBH BURNER:

$\dfrac{7000000\ B/H}{21825\ B/\#} = 321\ \#/H$

$Q = W C_p \Delta T$

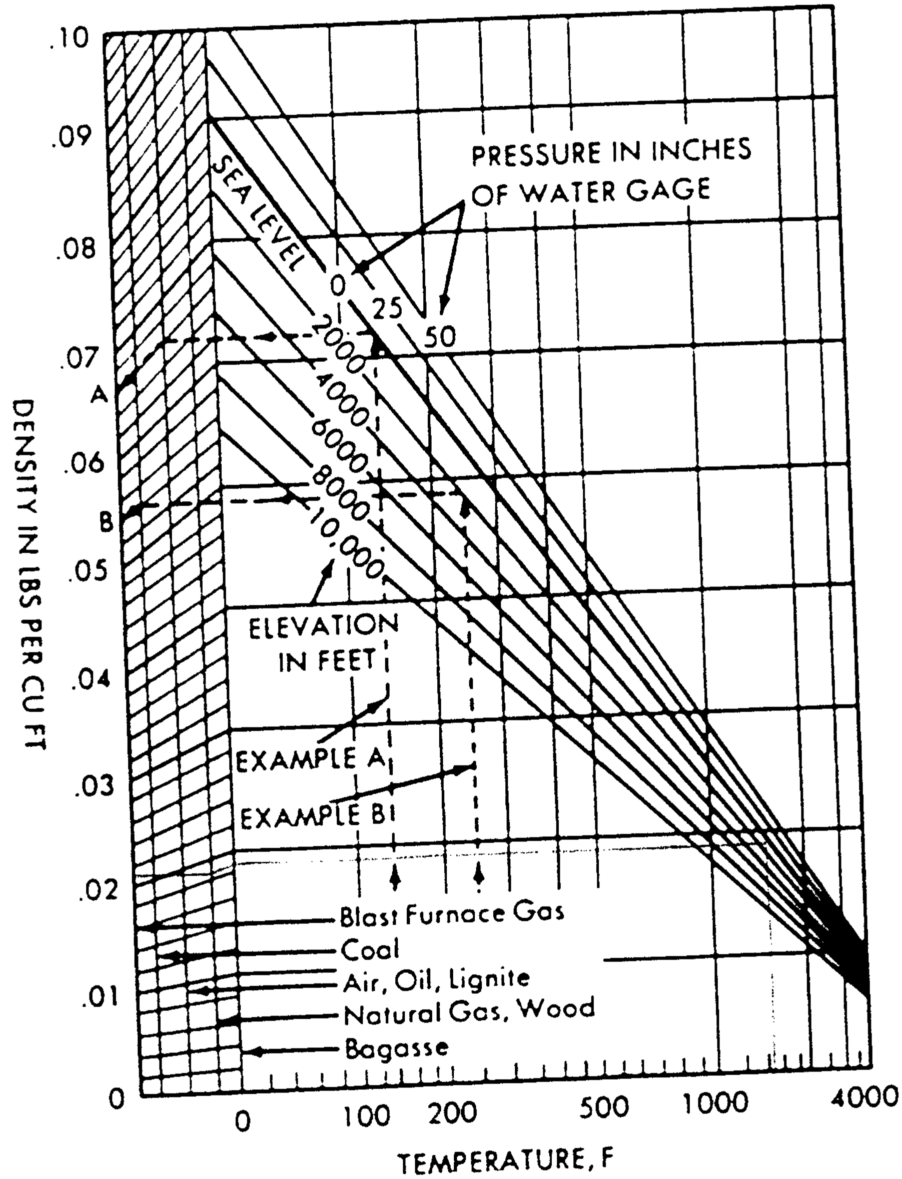
$7000000 = 27500\ (0.32)(T - 625)$

$T = 1420°F$ GAS ENTERING BOILER

15040-00

BLDG 7-A AUX BRNR RETROFIT

DENSITY OF AIR AND APPROXIMATE DENSITY OF FLUE GAS PRODUCED BY COMBUSTION OF COMMON FUELS (BASED ON AIR DENSITY OF .0735 AT 80F & 29.92")



Example		Density
A	Air at std atmospheric pressure (sea level) and 140 F	.0662 lb/cu ft
B	Flue gas from coal combustion — @4000 ft elevation and 250 F	.0543 lb/cu ft

Air....
Oxygen
Hydroge
Nitrogen
Carbon
Carbon
Methan
Acetyle
Ethylene
Ethane.
Sulphur
Hydrog
From

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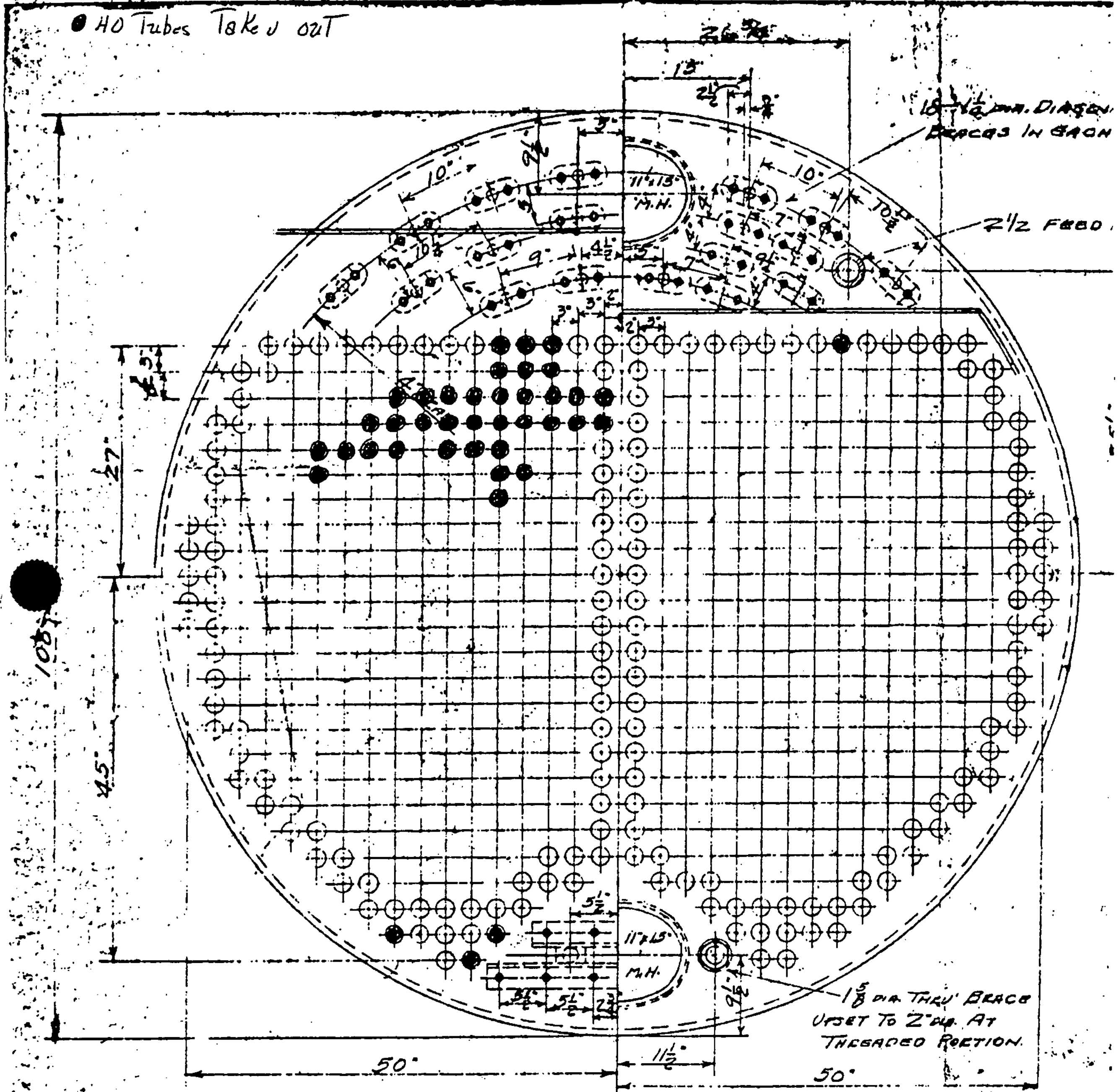
Route to________________

No. 3 Waste Heat Boiler Heat End

● 40 Tubes Taken out



HALF VIEW HEAD "A" HALF VIEW HEAD "B"
TUBE + BRACE LAYOUT FOR 700- 2" O.D. TUBES
SCALE 1"=1'-0"

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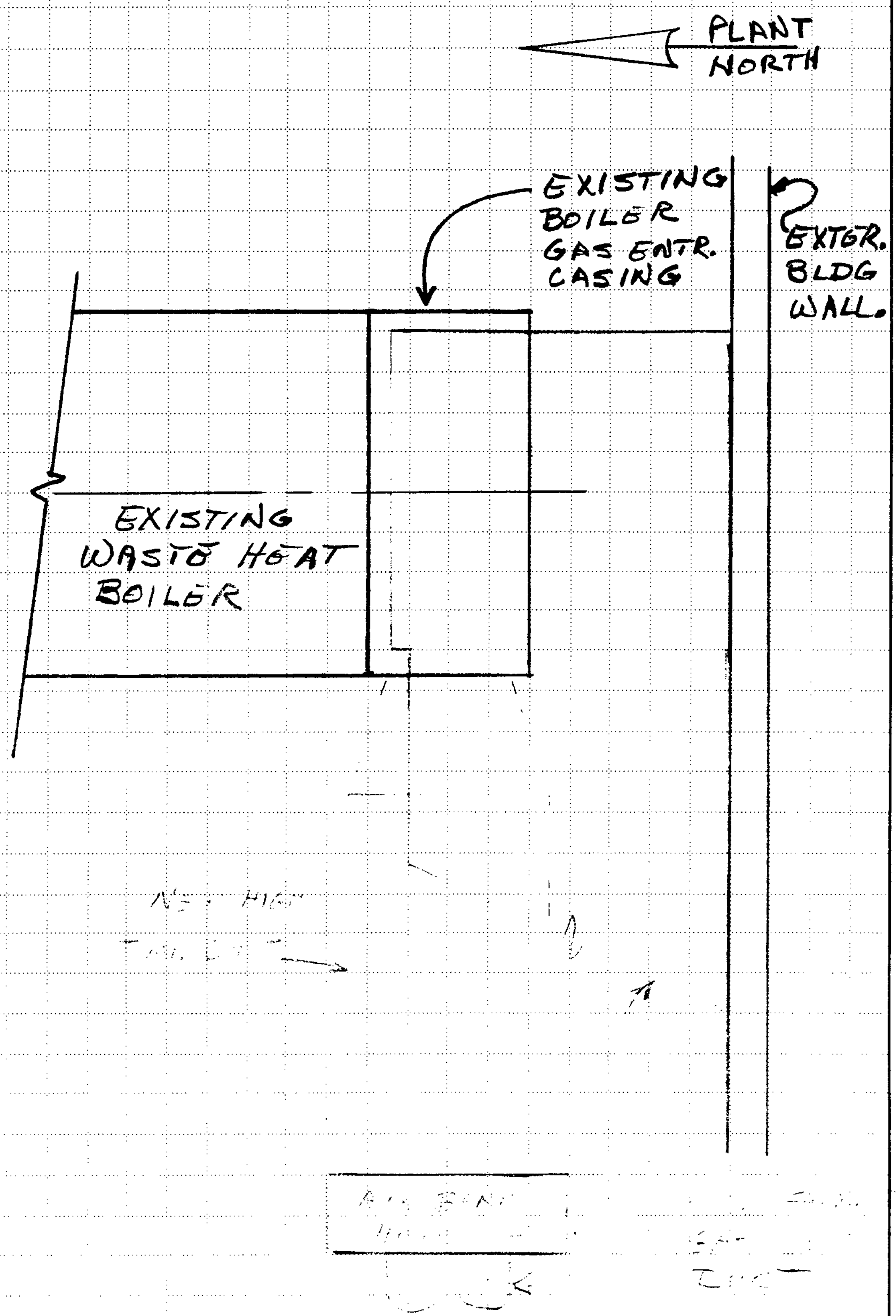
Calculations For: BLDG. NO. 7-A WASTE HEAT BOILER RETROFIT



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Calculations For: BLDG 7-A WASTE HT. BLR. RETROFIT

APPROX FLUE GAS SP. VOL @ 1425°F = $\frac{1}{0.021}$ = 47.6 $FT^3/\#$

FIRE TUBE MAX VEL = $\frac{(27200+312)(47.6)}{(60)(700)(0.0171)}$ = 1823 FPM

HEAT AVAILABLE FROM GASES:

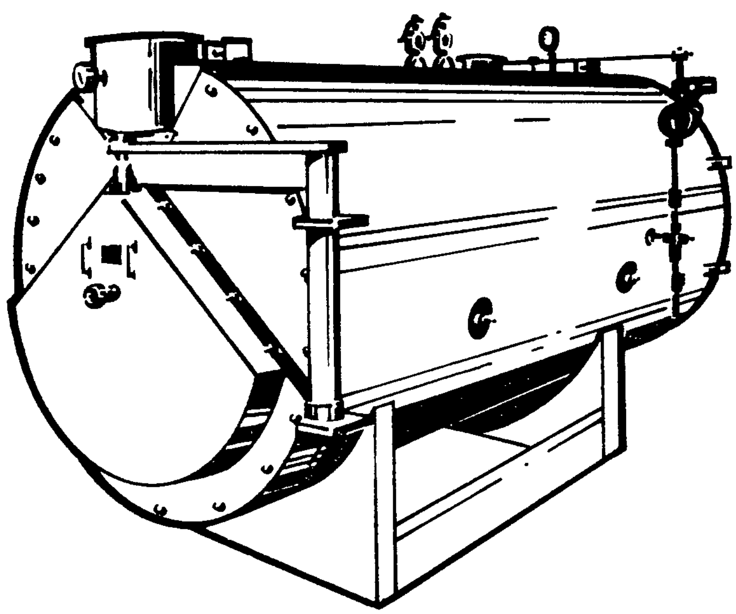
$Q = (27512\ \#/H)(382\ B/\# - 90\ B/\#) = 8{,}033{,}504$ BTUH

STEAM PRODUCED @ 100 PSIG SATURATED, WITH FD. WATER @ 225°F

$\frac{8{,}033{,}504}{(1189.7 - 193.18)} = 8060\ \#/HR$

SELECTION AND SIZING OF HEAT RECOVERY BOILERS

YORK SHIPLEY
AUTOMATIC BOILERS



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BOILERS • BURNER[redacted] SYSTEMS

202

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SELECTION OF HEAT RECOVERY BOILERS

BOILER HORSEPOWER AT VARIOUS WORKING PRESSURES FOR VARIOUS INLET GAS TEMPERATURES

The following table will provide the boiler horsepower for various working pressures and various inlet gas temperatures; however, should you want more exact data or if your operating conditions are not included in the table, use the procedure on the following pages.

In the following table, the horsepower is given for one thousand (1000) pounds of waste gas.

Determine pounds of waste gas (see steps 2, 3, & 4 on following page); then multiply the number of thousand pounds by the horsepower for the working pressure and inlet gas temperature.

Example: 15,000 Lbs./Hr. Working Pressure 150 PSI
Inlet Gas Temp. 1600°F.

15 x 8.4 = 126 Boiler HP

Boiler Horsepower for 1000 Lbs. Per Hr.
°F. Inlet Gas Temperature

W.P. RANGE P.S.I.	2000	1900	1800	1700	1600	1500	1400
0– 15	12.4	11.6	10.9	10.1	9.3	8.5	7.8
16– 50	12.0	11.3	10.5	9.7	8.9	8.2	7.4
51–100	11.8	10.9	10.2	9.4	8.6	7.9	7.1
101–125	11.6	10.8	10.1	9.3	8.5	7.8	7.0
126–150	11.5	10.7	10.0	9.2	8.4	7.6	6.9
151–200	11.3	10.6	9.8	9.0	8.2	7.5	6.7
201–250	11.2	10.4	9.7	8.9	8.1	7.3	6.6

Boiler Horsepower for 1000 Lbs. Per Hr.
°F. Inlet Gas Temperature

W.P. RANGE P.S.I.	1300	1200	1100	1000	900	800
0– 15	7.0	6.2	5.4	4.7	3.9	3.1
16– 50	6.6	5.8	5.1	4.3	3.5	2.7
51–100	6.3	5.5	4.8	4.0	3.2	2.4
101–125	6.2	5.4	4.7	3.9	3.1	2.3
126–150	6.1	5.3	4.5	3.8	3.0	2.2
151–200	5.9	5.1	4.4	3.6	2.8	2.0
201–250	5.8	5.0	4.2	3.4	2.7	1.9

The following procedure can be used to determine the amount of heat (BTU per Hr.) that can be recovered with a heat recovery boiler.

Step 1 - Determine the waste gas temperature.

Step 2 - Determine the amount of waste gas in Pounds per Hour.

Step 3 - If the amount of waste gas is measured in CFM - convert CFM to pounds using Table below:

Temp. °F.	Density in Pounds/Cu.Ft.
60°F. (Std)	0.0763
900°F.	0.0292
1000°F.	0.0272
1200°F.	0.0239
1400°F.	0.0214
1600°F.	0.0193
1800°F.	0.0176
2000°F.	0.0161
2500°F.	0.0134
3000°F.	0.0115

Step 4 - The following can be used to estimate the waste gas available from various processes:

Nat. gas produces 1.0 Lb. waste gas per Cu.Ft.
Oil produces 135 Lbs. waste gas per Gal.
Wood (dry) produces 10 Lbs. waste gas per Lb.
Wood (50% moist) produces 6 Lbs. waste gas per Lb.

Step 5 - The following equation can be used to determine the available heat from the waste gas:

$$\text{BTUH} = \underset{\text{(Step 2)}}{\text{Lbs. Gas}} \times .26 \times \left[\underset{\text{(Step 1)}}{\text{Waste Gas Temp.}} - \underset{\text{(See Below)}}{\text{Stack Temp.}}\right]$$

Use 350°F. for Low Press. Boiler Stack Temp.
500°F. for High Press. (150#) Boiler Stack Temp.
550°F. for High Press. (Over 150#) Boiler Stack Temp.

Example: 15,000 Lbs. Gas/Hr. at 1600°F.
150 PSI Steam Required

BTUH = 15,000 X .26 (1600 - 500)
BTUH = 4,290,000 (128 HP)

SELECTION OF BOILER SIZE

The following table will provide the boiler heating surface per boiler horsepower for various pressures and various inlet gas temperatures.

Using the horsepower from the chart on Page 1 or as calculated in accordance with the equation on Page 2, multiply the horsepower by the square feet of heating surface from the chart for the working pressure and inlet gas temperature.

Select a heat recovery boiler from the brochure with the proper heating surface. If the calculated heating surface falls between two sizes, use the larger size.

Example: 126 HP from table Page 1
Working Pressure 150 PSI
Inlet Gas Temp. 1600°F.

126 HP x 7.0 Sq.Ft./HP = 882 Sq.Ft. Heating Surface
Use Model HRH-1000

HEATING SURFACE PER BOILER HORSEPOWER, SQ. FT.

Press. Range P.S.I.	Gas Temperature °F. 2000	1900	1800	1700	1600	1500	1400
0- 15	4.7	5.0	5.3	6.0	6.3	6.9	7.1
16- 50	4.8	5.2	5.6	6.1	6.5	7.1	7.3
51-100	4.9	5.3	5.7	6.2	6.8	7.3	7.5
101-125	5.0	5.4	5.8	6.3	6.9	7.4	7.6
126-150	5.1	5.4	5.9	6.3	7.0	7.6	7.9
151-200	5.2	5.5	6.0	6.4	7.1	7.8	8.1
201-250	5.3	5.6	6.0	6.5	7.2	7.9	8.3

HEATING SURFACE PER BOILER HORSEPOWER, SQ. FT.

Press. Range P.S.I.	Gas Temperature °F. 1300	1200	1100	1000	900	800
0- 15	7.2	7.4	8.3	9.5	10.5	11.5
16- 50	7.5	7.7	8.7	9.9	10.9	11.9
51-100	7.8	8.0	9.2	10.2	11.3	12.4
101-125	8.0	8.3	9.4	10.4	11.8	12.9
126-150	8.1	8.4	9.5	10.6	12.2	13.5
151-200	8.3	8.6	9.8	10.9	12.4	13.8
201-250	8.5	8.8	10.0	11.2	12.9	14.3

CALCULATING PRESSURE DROP THROUGH BOILER

Step 1. Determine the standard CFM of waste gas.

Step 2. Correct the standard CFM by using the temp. correction factor from table below:

Temp. °F.	Temp. Corr. Factor	Temp. °F.	Temp. Corr. Factor
800°F	.88	1500°F	.98
900	.89	1600	1.00
1000	.90	1700	1.02
1100	.91	1800	1.04
1200	.92	1900	1.06
1300	.94	2000	1.08
1400	.96		

Step 3. Determine the Pressure Drop Correction Factor by dividing the corrected CFM by the base CFM from below and square the result.

$$\text{Press. Drop Corr. Factor} = \left[\frac{\text{Corrected CFM}}{\text{Base CFM}}\right]^2$$

Step 4. Determine the actual pressure by multiplying the base pressure drop from following table by the correction factor calculated in Step 3.

Model	Base CFM	Base Press. Drop	Model	Base CFM	Base Press. Drop
HR-125	220	.10" W.C.	HR-1000	1760	2.50" W.C.
HR-150	265	.20"	HR-1125	1980	3.00"
HR-200	350	.40"	HR-1250	2200	1.50"
HR-250	440	.65"	HR-1500	2640	2.20"
HR-300	525	.85"	HR-1750	3080	3.00"
HR-350	615	1.20"	HR-2000	3520	3.00"
HR-400	700	1.50"	HR-2500	4400	3.00"
HR-500	880	.85"	HR-3000	5280	4.50"
HR-625	1100	1.40"	HR-3500	6160	4.20"
HR-750	1320	2.00"	HR-4250	8800	4.00"
HR-875	1540	1.75"			

Example:

15,000 Lbs./Hr. at 1600°F.
Using HR-1000 Boiler

$$\frac{15{,}000 \text{ Lbs.}}{60 \times .0193 \text{ Lbs/Cu.Ft.}} = 12{,}953 \text{ ACFM}$$

12,953 ACFM X 1.00 = 12,953 Corr. CFM
(Above) (Step 2)

$$\text{Press. Drop Corr. Factor} = \left[\frac{12{,}953}{7{,}200}\right]^2$$

P.D.C.F. = 3.2

Actual Press. Drop = Base press. Drop X P.D.C.F.

Actual Press. Drop = 2.50" X 3.2

Actual Press. Drop = 8.0" W.C.

HEAT RECOVERY BOILERS

Standard Equipment:

A.S.M.E. Three Pass Boiler

3 Pc. Rear Cover (3 Pass Design)

2 Pc. Front Cover

Two Inches Insulation

Metal Jacket

Rear Head Refractory with Davit

Trim Consisting of:

- Safety Valves
- Press. Gauge
- Limit Control
- Water Column with L.W.C.O. and Pump Control, Gauge Glass and Try Cocks

Lifting Lugs

Front Furnace Protective Refractory

Control Wiring to Terminals in Junction Box

Optional Equipment:

Particulate Drops - Front and/or Rear

Soot Blowers

Inducer Brackets

Blowdown Valves

Steam Stop Valve

Steam Non-Return Valve

F.W. Stop/Check Valves

Abrasion resistant Refractory Rear Cover

Aux. L.W.C.O.

Vertical Vent (125 thru 750)

Front Cover Hinges (125 thru 750)

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PDL	10-26-95	95046-00
Checked By:	Date:	Sheet No: ____ of ____

Calculations For: CASE 6 & 7 No. 2 FUEL OIL STORAGE

PER REGULATION AR 420-49, 30 DAY SUPPLY IS REQUIRED.

No. 2 FUEL OIL –

HTG VALUE = 19 500 BTU/LB; 140000 BTU/GAL

7 #/GAL

BOILER – 30000 #/HR STEAM
295 GAL/H No. 2 OIL

STORAGE = 30D (24 H/D) (295 GAL/H) = 212,400 GALLONS

P10069

Appendix 2 - Cost Estimates/ Energy Cost Development

COST ESTIMATE ANALYSIS

PROJECT HOLSTON 30000#/HR BOILER	INVITATION NO./CONTRACT NO.	EFFECTIVE PRICING DATE	DATE PREPARED 10-26-95
	☐ CODE A ☐ CODE B ☐ CODE C	DRAWING NO.	SHT OF
LOCATION	☐ OTHER	ESTIMATOR PDL	CHECKED BY

TASK DESCRIPTION	QUANTITY		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
	No. of Units	Unit Meas	MH/Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit WT	Total WT
FIRETUBE BLR - 800 BHP	1	EA				40000				150000	190000		
DEAER. HTR/PUMP PKG.	1	EA				5000				25000	30000		
BREECHING		LS									7500		
PIPING, INSUL., ETC		LS									15000		
200K GAL TANK	1	EA									100000		
MECH. SUBTOTAL											342500		
ELECT. FDR'S, BRKRS, ETC		LS									20000		
TOTAL CONST. COST											362500		
NON-CONSTRUCTION COSTS													
BOILER LAYUP	3	EA									225000		
TURB'S, PUMPS, DISTR.													
SYS. LAYUP		LS									25000		
TOTAL LAYUP											250000		
TOTAL THIS SHEET													

PAGE

COST ESTIMATE ANALYSIS

PROJECT HOLSTON/VAAP BOILERS	INVITAT[illegible]NO./CONTRACT NO.	EFFECTIVE PRICING DATE	DATE PRE[illegible] 9-1-95
LOCATION	☐ CODE A ☐ CODE B ☐ CODE C ☐ OTHER	DRAWING NO.	SHT 1 OF 4
		ESTIMATOR PDL	CHECKED BY

TASK DESCRIPTION	QUANTITY		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
Summary	No. of Units	Unit Meas	MH/Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit WT	Total WT
MECH.											221375		
ELECT.											45400		
TRANSP.											50000		
SYSTEM STARTUP											25000		
TOTAL CONSTR.											#341,775		
NON-CONSTR. COSTS:													
COAL BLR. LAYUP	3	EA									225 000		
TOTAL THIS SHEET													

PAGE

COST ESTIMATE ANALYSIS

PROJECT HOLSION/VAAP BOILERS	INVITA NO./CONTRACT NO.	EFFECTIVE PRICING DATE	DATE PRE 8-24-95
LOCATION	☐ CODE A ☐ CODE B ☐ CODE C ☐ OTHER	DRAWING NO. PDL	SHT 2 OF 4
		ESTIMATOR	CHECKED BY

TASK DESCRIPTION	QUANTITY		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
	No. of Units	Unit Meas	MH/Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit WT	Total WT
VALVES [illegible]													
4" F[illegible] CWIKL	2	EA	8	16	50-	800	-	-	25-	50	850		
10" S[illegible]	2	EA	8	16	"	800			"	50	850		
4" SIM. STM. VLVS	4	EA	16	64	"	3200			"	100	3300		
4" N.G. S[illegible] VLVS	4	EA	4	16	"	800			"	100	900		
4" N.G. FL.[illegible]	2	EA	4	8	"	400			"	50	450		
N.G. MN. [illegible]	1	EA	4	4	"	200			"	25	225		
N.G. MN. REF.	1	EA	4	4	"	200			"	25	225		
[illegible] Co. CNTL. REMO		L.S.									75000		
10" B.W. S[illegible]	80	LF			47.00	3760	3.75	300	120.00	9600	13660		
S[illegible] /BACK"	"	"			9.56	765	-		13.45	1076	1841		
4" Sch.80 B.W. FD. [illegible]	"	"			18.35	2753	2.29	344	24.00	3600	6696		
FW [illegible] JACK"	"	"			6.87	1031	-		5.07	761	1792		
[illegible] -N.G.	8[illegible]	LF			1.00	850	1.15	978	-		1828		
[illegible]					6.35	5398	2.77	2355	17.25	14663	22415		
[illegible]	22	[illegible]			68-	1496	2.41	53	100-	2200	3749		
MISC. [illegible]													
VALVE [illegible]	-	L.S.									45000		
[illegible]	300	LBS			5.00	15000	-		20.00	6000	21000		
DUCT INSUL.	1500	SF.			4.79	7185	-		9.60	14400	21585		
TOTAL THIS SHEET											221366		

PAGE

COST ESTIMATE ANALYSIS

PROJECT HOLSTON/VAAP BOILERS	INVITATION NO./CONTRACT NO.	EFFECTIVE PRICING DATE	DATE PREPARED
	☐ CODE A ☐ CODE B ☐ CODE C	DRAWING NO.	SHT 3 OF 4
LOCATION	☐ OTHER ______	ESTIMATOR PDC	CHECKED BY

TASK DESCRIPTION	QUANTITY		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
	No. of Units	Unit Meas	MH/Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit WT	Total WT
TRANS[illegible]ING		LS									50000		
BOIL[illegible] ST[illegible]		LS									25000		
ELECTRICAL :													
TOTAL THIS SHEET													

COST ESTIMATE ANALYSIS

INVITATIO /CONTRACT NO.

EFFECTIVE PRICING DATE MR

DATE PREPA 8/30/95

PROJECT HOLSTON/VAAP BOILERS

LOCATION

☐ CODE A ☐ CODE B ☐ CODE C

☐ OTHER

DRAWING NO.

SHT 4 OF 4

ESTIMATOR

CHECKED BY

TASK DESCRIPTION	QUANTITY		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
	No. of Units	Unit Meas	MH/Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit WT	Total WT
2300V CB	1	ea			2.5k	2,500	1k	1,000	5k	5,000	8,500		
2300V TERMIN.	3	ea			31	93	—	—	104	312	405		
2300V/480V XFMR	1	ea			1000	1,000	500	500	10000	10,000	11,500		
2300V TERMIN.	3	ea			31	93	—	—	104	312	405		
480V TERMIN	3	ea			28^{50}	85^{50}	—	—	10^{05}	30^{15}	115^{65}		
480V SWGR/800A	1	ea			2000	2000	750^{00}	750^{00}	5700	5700^{00}	$8,450^{00}$		
↳ w/ 3-350A CB's													
480V TERMIN	3	ea			28^{50}	85^{50}	—	—	10^{05}	30^{15}	115^{65}		
COMBO STARTER	2	ea			650	1,300	50	100	5500	11,000	3,400		
↳ 400A/NEMA 5													
WIRING & CONDUIT													
#4 PRIMARY	600	LF			1.04	624	0.03	18^{00}	1.12	672^{00}	1,314		
#8 G	200	LF			0.18	36	0.01	2^{00}	0.46	92^{00}	130		
4" PVC	200	LF			505	1,010	—	—	4.85	970^{00}	1,980		
#350 KCM	75	LF			1.25	93^{75}	0.02	1.50	2.85	213^{75}	309		
#2 G	25	LF			0.51	12^{75}	0.01	0.25	0.61	15^{25}	28^{25}		
3" PVC	25	LF			4.15	103^{75}	—	—	3.40	85^{00}	188^{75}		
										Σ	36,841.30		
							CONTING		10%		3,684.13		
							O/H&P				40,525.43		
								→	12%		4,863.05		
										#	45,388.48		
TOTAL THIS SHEET							SAY #50,000*						

PAGE

Kingsport Power Company
PO BOX [illegible] KINGSPORT TN 3766[illegible]

1-615-578-2200

Account Number: H | 1 | 111 | 93 | 13300 | 0 | 4

HOLSTON ARMY AMM PLANT
P3-050-0701 CONT# DAAA09-70-C-0320
P O BX 749
KINGSPORT TN 37662

1011931300034 0140028750140028757

MARCH 1995

Please Return This Portion
With Your Payment

Gross Amount	Last Pay Date For Net Amount	Net Amount
14[illegible],[illegible]23.75	APR 12	140,028.75

Meter Types
K - Kilowatt Hour
D - KW Demand
A - KVA Demand
R - RKVAH
V - KVAR Demand

Codes
E - Estimated
C - Meter Change
O - Off Peak

Account Number: (Please Use When You Call or Write)
1 111 93 13300 0 4

Service Address
HOLSTON ARMY AMM PLANT
CONTR NO W-1911-ENG-5
KINGSPORT TN 37660

Month MARCH 1995 Tariff 324 IP TRAN Office KINGSPORT

Service From	Service To	Type	Meter Number	Previous Readings	Present Readings	Meter Constant	Metered Usage	Voltage Constant
02-23	03-24	K	84741	07389	07558	24000.	4056000	
02-23	03-24	R	84740	04572	04627	24000.	1320000	
02-23	03-24	D	84741		.331	24000.	7944.0	
02-23	03-24	V	84740		.154	24000.	3696.0	
02-23	03-24	K	33223	0038	0038	6000.		
02-23	03-24	D	33223		.020	6000.	120.0	
02-23	03-24	R	33223	0330	0340	6000.	60000	
02-23	03-24	V	33223		.025	6000.	150.0	

Contract Capacity	10,500
Billing KVAR	
RKVAH	1,380,000
Metered Demand	8,064.0
Power Factor	
Billing Demand	8,064.0
Metered KWH	4,056,000
Power Factor Constant	
Adjusted KWH	4,056,000
Voltage Adj KWH	
Billing KWH	4,056,000

RATE BILLING		154,111.36
FUEL ADJ	.00[illegible]9462-	11,950.19CR
PROMPT PAYMENT DISCOUNT		2,132.42CR
TOTAL AMOUNT DUE		140,028.75

KINGSPORT POWER

TARIFF I. P.
(Industrial Power)

AVAILABILITY OF SERVICE

Available to industrial and large commercial customers. Customers shall contract for a definite amount of electrical capacity in KW which shall be sufficient to meet normal maximum requirements but in no case shall the capacity contracted for be less than 3,000 KW. Contract capacities will be specified in multiples of 100 KW.

MONTHLY RATE

Tariff Code	Service Voltage	Demand Charge per KW	Energy Charge per KWH	Service Charge
322	Primary	$ 8.70	2.302 cents	$ 240.00
323	Subtransmission	$ 7.79	2.269 cents	$ 730.00
324	Transmission	$ 7.60 HDC	2.241 cents	$1,930.00 HDC

Reactive Demand Charge for each Kilovar of Lagging Reactive Demand in excess of 50 percent of the KW of monthly metered demand . . . . $ 0.75 per KVAR

MINIMUM CHARGE

This tariff is subject to a minimum monthly charge equal to the sum of the service charge, the product of the demand charge and the monthly billing demand and the fuel clause adjustment.

FUEL CLAUSE

When the unit cost of fuel in the charges for power purchased from Appalachian Power Company under Federal Energy Regulatory Commission rate schedule No. 23 is above or below a base unit price of 15.8563 mills per KWH, adjusted for losses, the bill for service shall be increased or decreased respectively at a rate per KWH equal to the amount that such cost of fuel is above or below the unit base cost of 15.8563 mills per KWH, adjusted for losses, applied to the KWH measured in the period for which the bill is rendered. The adjustment shall be based on the most recent calendar month for which fuel cost data is available.

PROMPT PAYMENT DISCOUNT

A discount of 1.5 percent will be allowed if account is paid in full within 15 days of date of bill.

DETERMINATION OF DEMAND

The billing demand in KW shall be taken each month as the single highest 30-minute integrated peak in KW as registered during the month by a demand meter or indicator, or, at the Company's option, as the highest registration of a thermal type demand meter or indicator, but the monthly billing demand so established shall in no event be less than 60% of the greater of (a) the customer's contract capacity or (b) the customer's highest previously established monthly billing demand during the past 11 months nor less than 3,000 KW.

The reactive demand in KVARS shall be taken each month as the single highest 30-minute integrated peak in KVARS as registered during the month by a demand meter or indicator, or, at the Company's option, as the highest registration of a thermal type demand meter or indicator.

METERED VOLTAGE

The rates set forth in this tariff are based upon the delivery and measurement of energy at the same voltage, thus measurement will be made at or compensated to the delivery voltage. At the sole discretion of the Company, such compensation may be achieved through the use of loss compensating equipment, the use of formulas to calculate losses or the application of multipliers to the metered quantities. In such cases, the metered KWH and KW values will be adjusted for billing purposes. If the Company elects to adjust KWH and KW based on multipliers, the adjustments shall be in accordance with the following:

1. Measurements taken at the low-side of a customer-owned transformer will be multiplied by 1.01.
2. Measurements taken at the high-side of a Company-owned transformer will be multiplied by 0.98.

United Cities Gas Company

CUSTOMER NO. 66444-1 METER NO. S9225055

MAIL ADDRESS: SERVICE ADDRESS:

501 S WILCOX DR

732 N EASTMAN RD
E 2A
GSPORT, TN 37664
615 245-4189

HOLSTON DEFENSE
C/O HOLSTON DEFENSE
4509 W. STONE DR
KINGSPORT, TN 37660

DATE BILLED	RATE CODE
5/04/95	240-7

RATE SCHEDULE AVAILABLE UPON REQUEST IN LOCAL OFFICE.

BILLING PERIOD FROM	TO	METER READING PREVIOUS	PRESENT	PRESSURE FACTOR	MULTIPLIER	CCF USED	BTU FACTOR	THERMS USED
3/31/95	4/30/95	115916	121258	1.0000		53420	1.0000	53420

MESSAGES

DON'T HAVE YOUR GAS TURNED OFF INSTALL A GAS WATER HEATER AND HAVE ALL THE HOT WATER YOU NEED AT LESS COST. NO SERVICE CALL IN THE FALL TO RESTORE SERVICE. YOUR GAS HEAT WILL BE READY WHEN YOU NEED IT. CALL TODAY ABOUT OUR WATER HTR PGM.

DESCRIPTION	AMOUNT
CURRENT MONTH CHARGES	
GAS CHARGES	12,300.04
DEMAND CHARGE	9,409.24
DEMAND PGA	633.63CR
PAYMENT RECEIVED - THANK YOU 4/17/95 30862.79	

5/9/95

STOMER DEPOSIT INFORMATION
R DEPOSIT
DATE OF DEPOSIT
DATE OF REFUND

COMPARATIVE USAGE INFORMATION				
BILLING	DAYS	USAGE	DAILY AVG. USAGE	DEGREE DAYS
CURRENT	30	53420	1780.67	273
LAST YEAR	30	127190	4239.67	

THIS AMOUNT DUE NOW $21,075.65

PAST DUE AFTER THIS DATE 5/19/95 PAY THIS AMOUNT $22,129.43

DUE DATE DOES NOT EXTEND PAYMENT OF ANY PREVIOUS BALANCE DUE
RETAIN THIS SECTION FOR YOUR RECORDS
FAILURE TO RECEIVE STATEMENT DOES NOT RELIEVE CUSTOMER OF RESPONSIBILITY TO PAY AMOUNT DUE

DETACH AND RETURN THIS SECTION WITH YOUR PAYMENT
PLEASE DO NOT STAPLE, FOLD OR MUTILATE

CUSTOMER NO. 66444-1 CYCLE NO. 23

MAKE CHECKS PAYABLE TO
UNITED CITIES GAS CO.
P O BOX 2970
JOHNSON CITY, TN 37605

HOLSTON DEFENSE
C/O HOLSTON DEFENSE
4509 W. STONE DR
KINGSPORT, TN 37660

THIS AMOUNT DUE NOW $21,075.65

PAST DUE AFTER THIS DATE 5/19/95 PAY THIS AMOUNT $22,129.43

5910066444100022129430002107565000210756 5

PLEASE INDICATE AMOUNT OF YOUR PAYMENT

PETROLEUM TESTING FACILITY - EAST
NEW CUMBERLAND, PA 17070-50C

Coal Analysis Report

02/28/94

Installation: CDR HOLSTON DEFENSE CORP
4509 WEST STONE DRIVE
KINGSPORT TN 37660-9982

Delivery Date: 10-FEB-94
Date Received: 24-FEB-94

Mine Name:	RED RIVER	Can Number:	1737
County, State:	VA	Sample Number:	93114B
Contractor:	ONYX INTER	Activity Code:	AR11
Contract Number:	DLA600-93-D-0674	Lab Number:	4056
Item Number:		Coal Sampler's Number:	92-6
Tons Reprst'd:	918.80		
Size & Kind:	1 3/4" X 3/8"		

Car, Truck or Barge Number:
NW12210, 168252, 133447, 11601, 75904, 168265, 145446, 94956, 12230, 167330, NS312326

TESTS		RESULTS [As Recd]	[Moisture Free]
Air Dry Loss:	2.03		
Total Moisture:		2.9	
Volatile Matter:		34.7	35.7
Fixed Carbon:		56.1	57.8
Ash:		6.3	6.5
Sulfur:		0.73	0.75
Htg Val-Btu/lb:		13900	14320

Ash Fusion Temp (Deg F)
Initial:
Softening:
Hemi:
Fluid:

Free Swelling Index:

Hardgrove Grind Ind:

Remarks:

Approved By: Gary L Smith

Date: 2/28/94

GARY L. SMITH
Chief, Product Assurance Division

USAPC FL 707-E
0[illegible]r 92

(730)

'S ARMY PETROLEUM CENTER
PETROLEUM TESTING FACILITY - EAST
NEW CUMBERLAND, PA 17070-5005

Coal Analysis Report

04/14/94

Installation:	CDR HOLSTON DEFENSE CORP 4509 WEST STONE DRIVE KINGSPORT TN 37660-9982	Delivery Date: Date Received:	21-MAR-94 05-APR-94

ine Name:	RED RIVER	Can Number:	0016
ounty, State:	VA	Sample Number:	93132B
ontractor:	ONYX INTER	Activity Code:	AR11
ontract Number:	DLA600-93-D-0674	Lab Number:	4074
tem Number:		Coal Sampler's Number:	92-3
ons Reprst'd:	998.30		
ize & Kind:	1 3/4" X 3/8"		

ar, Truck or Barge Number:
W5981, 143864, 131074, 3737, 92219, 6168, 7780, 118683, 12742, 145302, NS336022
SOU76864

ESTS		RESULTS [As Recd]	[Moisture Free]
ir Dry Loss:	1.39		
otal Moisture:		2.3	
olatile Matter:		33.7	34.5
i Carbon:		58.7	60.1
s		5.3	5.4
ulfur:		0.70	0.72
tg Val-Btu/lb:		14270	14610

sh Fusion Temp (Deg F)
Initial:
Softening:
Hemi:
Fluid:

ree Swelling Index:

ardgrove Grind Ind:

emarks:

Approved By: Gary L. Smith   Date: 4/14/94

GARY L. SMITH
Chief, Product Assurance Division

S. FL 707-E
1 Apr 92   (730)

US ARMY PETROLEUM CENTER
PETROLEUM TESTING FACILITY - EAST
NEW CUMBERLAND, PA 17070-5005

Coal Analysis Report

06/17/94

nstallation: CDR HOLSTON DEFENSE CORP
4509 WEST STONE DRIVE
KINGSPORT TN 37660-9982

Delivery Date: 25-MAY-94
Date Received: 10-JUN-94

ine Name: RED RIVER
ounty, State: VA
ontractor: ONYX INTER
ontract Number: DLA600-94-D-0670
tem Number:
ons Reprst'd: 922.85
ize & Kind: 1 3/4" X 3/8"

Can Number: 0470
Sample Number: 9416B
Activity Code: AR11
Lab Number: 4095
Coal Sampler's Number: 92-2

ar, Truck or Barge Number:
IW3142, 10408, 3004, 11945, 93533, 5219, 94167, 117629, SOU352051, 77068, 78855

ESTS		RESULTS [As Recd]	[Moisture Free]
ir Dry Loss:	2.16		
otal Moisture:		3.8	
olatile Matter:		33.9	35.2
ix ' Carbon:		57.7	60.0
sh		4.6	4.8
ulfur:		0.78	0.81
tg Val-Btu/lb:		14040	14600

sh Fusion Temp (Deg F)
Initial:
Softening:
Hemi:
Fluid:

ree Swelling Index:

ardgrove Grind Ind:

emarks:

Approved By: Gary L Smith

Date: 6/20/94

GARY L. SMITH
Chief, Product Assurance Division

JS FL 707-E
01 Apr 92

(730)

3 ARMY PETROLEUM CENTER
PETROLEUM TESTING FACILITY - EAST
NEW CUMBERLAND, PA 17070-5005

Coal Analysis Report

10/25/94

nstallation:	CDR.HOLSTON DEFENSE CORP 4509 WEST STONE DRIVE KINGSPORT TN 37660-9982	Delivery Date: Date Received:	03-OCT-94 13-OCT-94

ne Name:	RED RIVER	Can Number:	0852
ounty, State:	VA	Sample Number:	94047A
ontractor:	ONYX INTER	Activity Code:	AR11
ontract Number:	DLA600-94-D-0670	Lab Number:	5004
tem Number:		Coal Sampler's Number:	92-2
ons Reprst'd:	984.9		
ze & Kind:	1 3/4" X 3/8"		

r, Truck or Barge Number:
V68562, 119358, 68502, 146192, 94349, 168269, 10252, 144945, 75163, NS327477,
86307, SOU351223

ESTS		RESULTS [As Recd]	[Moisture Free]
r Dry Loss:	2.13		
otal Moisture:		3.4	
olatile Matter:		35.2	36.4
x Carbon:		55.7	57.7
sh		5.7	5.9
ulfur:		0.88	0.91
g Val-Btu/lb:		14010	14500

sh Fusion Temp (Deg F)
Initial:
Softening:
Hemi:
Fluid:

ee Swelling Index:

rdgrove Grind Ind:

marks:

Approved By: Gary L. Smith   Date: 11/25/94

GARY L. SMITH
Chief, Product Assurance Division

A L 707-E
Apr 92

(730)

5 ARMY PETROLEUM CENTER
PETROLEUM TESTING FACILITY - EA
NEW CUMBERLAND, PA 17070-5005

Coal Analysis Report

01/24/9

stallation: CDR HOLSTON DEFENSE CORP
4509 WEST STONE DRIVE
KINGSPORT TN 37660-9982

Delivery Date: 06-JAN-95
Date Received: 18-JAN-95

Mine Name: RED RIVER
County, State: VA
Contractor: ONYX INTER
Contract Number: DLA600-94-D-0659
Item Number:
Tons Reprst'd: 935.55
Size & Kind: 1 3/4" X 3/8"

Can Number: 0028
Sample Number: 94067A
Activity Code: AR11
Lab Number: 5024
Coal Sampler's Number: 92-14

Car, Truck or Barge Number:
NW143778, 117599, 11517, 142405, 146022, 145718, 92688, 9647, 7019, 143234, SOU351343

TESTS		RESULTS [As Recd]	RESULTS [Moisture Free]
Air Dry Loss:	0.82		
Total Moisture:		1.8	
Volatile Matter:		36.8	37.5
Fixed Carbon:		54.6	55.6
sh:		6.8	6.9
fur:		0.85	0.87
Htg Val-Btu/lb:		13990	14240

Ash Fusion Temp (Deg F)
Initial:
Softening:
Hemi:
Fluid:

Free Swelling Index:

Hardgrove Grind Ind:

Remarks:

Approved By: Gary L. Smith

Date: 1/24/95

GARY L. SMITH
Chief, Product Assurance Division

USAPC FL 707-E
Apr 92

(730)

AFFILIATED ENGINEERS SE, INC.
3300 SW Archer Road/P.O. Box 1086
Gainesville, FL 32608
(904) 376-5500
(904) 378-3081 - Fax

Made By:	Date:	Job No:
PDL	11-1-95	95046-00
Checked By:	Date:	Sheet No: ____ of ____

Calculations For:
VALUES FOR USE IN SPREADSHEETS

REFERENCE: (1) COST CENTER 2230 PRINTOUT - 11 MAY '95
(2) 1994 OUT-OF-POCKET COST - J. BOUCHILLON
DATED 3-29-95

OVERHEAD COST (2) = 5.92 - 4.25 = \$1.67 PER THOUSAND LBS. STM.

MONTHLY OVERHEAD (2) = 581607 (1.67)/12 = \$80,940 TOTAL COST

ASSUMING 85% IS FIXED: USE \$70,000

VARIABLE: 1.67 (0.15) = 0.25 \$/THOUSAND LBS STM.

MAINTENANCE COST (2) = 419000 + 309800 = \$728800 IN '94

MONTHLY MAINTENANCE (2) = $\frac{728800}{12}$ = \$60,733

USE ROUTINE MNTNC AS FIXED (2): $\frac{419000}{12}$ = \$34917 PER MO.

CHECK AVG. MNTH. CPP EST. (1): 28322 + 3454 = \$31,776 /MO.

CHECK AVG MNTH CPP EST. MJR (1): 11992 + 6502 + 5827 = \$24321/MO

$\frac{31776}{31776 + 24321} = 0.566$

USE 60/40 SPLIT FOR FIXED/VAR MNTNC.

VARIABLE MNTNC. = $0.4\left(\frac{728800}{581607}\right) = 0.50$ \$/THOUSAND LBS STEAM

.DATE 11 MAY 95 15:17:35 RID 1200 11 MAY 95 M7971
* CPP VS ACT - APR 1995

* COST.EXP. * CNTR.TYP.SFX.DESCRIPTION	AVG MTH. CPP EST.	APR MTH. ACT CST.	PCT OF EST.	ANNUAL CPP EST.
2230 STEAM - AREA A	0		0%	0
2230 046 000 DISODIUM PHOSPHATE (573)	76	34	45%	912
2230 118 000 ROCK SALT (5629)	153	116	76%	1837
2230 137 000 BITUMINOUS COAL	124491	81254	65%	1493893
2230 141 000 SODIUM SULFITE (5613)	7	2	29%	80
2230 143 000 SULFURIC ACID (560)	1195		0%	14337
2230 306 051 LBR-DEPARTMENTAL OPERATIONS-OPER	66235	43781	66%	794818
2230 400 000 DEPT SUPPLIES & MISC EXPENSES	521	221	42%	6250
2230 402 000 CLITHING	0		0%	
2230 414 998 PRODUCTION FUNDED EQUIPMENT MTL	21	261	1243%	250
2230 714 721 SUB-CON CINDER/FLYASH RECOVERY	317	1110	350%	3800
2230 764 994 ROUTINE MAINT - SUBCONTRACT	0	164	0%	0
2230 764 997 ROUTINE MAINT - HDC LBR @ CPP EST	28322	22074	78%	339867
2230 764 998 ROUTINE MAINT - MATERIALS	3454	7004	203%	41453
2230 766 994 MAJOR MAINT - SUBCONTRACT	11992		0%	14390
2230 766 997 MAJOR MAINT - HDC LBR @ CPP EST	6502	431	7%	78028
2230 766 998 MAJOR MAINT - MATERIALS	5827		0%	69929
2230 767 997 LBR-S&M CINDER/FLYASH RECOVERY	0	-436	0%	
2230 781 997 LBR-S&M MATERIAL HANDLING	63		0%	756
2230 791 997 LBR-S&M FLYASH HANDLING	95		0%	1137
TOTAL STEAM - AREA A	249,271	156,016	63%	2,991,254

..... END REPORT .....

1994 OUT-OF-POCKET COST FOR STEAM, BLDG 8-A.

Ref: Area A Monthly Usage Report

Sum of individual boilers output ("Steam Produced") = 695,702,000 lbs (Ref)

Bldg net steam output = Sum − internal consumption (DA, turbine, etc) (16.4% per EKAD study 1992 p. C-4)

= 695.7 m lbs × .836 = 581,607,000 lbs

Btu content of coal = 35,693 (Ref) × 2000 × 14,100 $\frac{Btu}{lb}$ = 1,007 mm Btu

Cost of FW for makeup water = (Steam rate − Cond. return + blowdown) FW unit cost

= S.R. − 60% + 7% = SR × 1.53

$$= \frac{695,702,000 \times 1.53 \times .148 \ \$/1000\ gal}{365 \times 24 \times 7.89 \times 60} = \$3,704/yr$$

Cost of electricity (motors, precipitators, etc.) (cost ctr 2230)

164,000 $\frac{KWH}{m}$ × .035 $\frac{\$}{KWH}$ × 12 mo = \$68,880/yr

cost of flyash disposal $\left(\frac{5,163\ c.y.}{8,077\ "B"}\right)$ × \$37,000 (cost for "B") = \$23,600/yr

cost of Water treatment Chemicals: Ref

Rock Salt 101,040 lb × .02 \$/lb = \$2,020

Caustic 515,718 lb × .0438 \$/lb = \$22,588

Sulfuric Acid 132,584 lb × .035 \$/lb = 4640 → \$29,250/yr

$$\text{Out-of-Pocket Steam Cost} = \frac{\text{Coal + electricity + water Chemicals + FW + waste water treatment} (<5{,}000) \text{ + flyash disposal}}{\text{bldg steam output}}$$

$$OPSC = \frac{\underbrace{(\$45 \times 35693)}_{\$1.61\ million} + \$68,880 + \$29,250 + 3700 + \underset{(est)}{5000} + \$23,950}{581,607,000} = \frac{\$1.74\ million}{581,607\ K\ lbs}$$

OUT of Pocket Steam Cost = $\boxed{3.00 \ \frac{\$}{1000\ lbs}}$ Not counting Maintenance costs of \$419,000 (routine) (per Mary Bailey)

\$309,795 (major)

728,795

Steam Cost = $\frac{\$1.74\ million + 729{,}000}{581,607}$ = $\frac{\$2.47\ million}{K}$ = $\boxed{4.25 \ \frac{\$}{1000\ lbs}}$ (counting maintenance) actual cost for Area A steam plant

$\frac{\$3.44\ million}{581,607\ K\ lbs}$ = $\boxed{5.92 \ \frac{\$}{K\ lbs} \text{ incl. overhead}}$

— J Beuchillon 3/29/95

AREA A MONTHLY USAGE AND PRODUCTION REPORT

Month	Steam Produced (K Lbs.)	Evaporation Rate (%)	A-8 Coal (Tons)	A-8 Cinders Shipped (Cu.Yds.)	Flyash Shipped On-Site (Cu.Yds.)	Flyash Shipped Off-Site (Cu.Yds.)	Disodium Phosphate (Lbs.)	Sodium Sulfite (Lbs.)	Rock Salt (Lbs.)	Sulfuric Acid (Lbs.)	Gas Producers (K Cu. Ft.)	A-10 Ga Produce Coal (Tons)
Jan. 92	89,572.0	10.1	4,369.3	776.0	726.0		108.0	83.0	1,040.0	9,118.0	96,890.0	1,147
Feb. 92	79,422.0	9.9	3,919.2	737.0	660.0	33.0	101.0	60.0	11,440.0	6,913.0	103,263.0	1,079
Mar. 92	92,748.0	9.8	4,644.0	904.0	759.0	165.0	110.0	63.0	9,360.0	11,682.0	136,934.0	1,313
Apr. 92	81,590.0	9.4	4,229.0	790.0	793.0	198.0	114.0	96.0	3,120.0	9,365.0	110,228.0	1,189
May 92	84,530.0	9.0	4,591.1	986.5	726.0	231.0	225.0	72.0	3,000.0	11,663.0	104,003.0	1,038
Jun. 92	62,588.0	10.1	3,050.4	584.5	660.0	66.0	121.0	65.0	27,760.0	9,227.0	65,752.0	759
Jul. 92	83,096.0	9.6	4,257.0	951.0	693.0	198.0	114.0	67.0	2,080.0	9,075.0	120,189.0	1,166
Aug. 92	81,898.0	9.6	4,191.1	612.0	693.0	132.0	111.0	64.0	1,440.0	9,953.0	96,179.0	1,035
Sep. 92	87,044.0	9.7	4,431.1	738.0	942.0	165.0	140.0	51.0	11,960.0	9,600.0	83,983.0	907
Oct. 92	79,438.0	9.6	4,051.2	707.0	726.0	264.0	147.0	84.0	8,320.0	8,153.0	93,234.0	1,001
Nov. 92	76,005.0	9.1	4,131.4	847.0	647.0	330.0	125.0	51.0	1,040.0	7,716.0	55,267.0	695
Dec. 92	90,986.0	9.4	4,762.6	896.0	726.0	330.0	159.0	50.0	11,440.0	11,526.0	88,910.0	996
TOTALS	988,917.0	9.8	50,627.4	9,529.0	8,751.0	2,112.0	1,575.0	806.0	92,000.0	113,991.0	1,154,832.0	12,331
AVERAGE	82,409.8	9.6	4,218.9	794.1	729.3	192.0	131.3	67.2	7,666.7	9,499.3	96,236.0	1,027
Jan. 93	100,650.0	9.2	5,376.2	950.0	198.0	743.0	169.0	48.0	7,280.0	5,231.0	103,278.0	1,041
Feb. 93	83,448.0	9.5	4,328.2	810.0	363.0	624.0	159.0	41.0	7,280.0	4,629.0	62,995.0	685
Mar. 93	87,670.0	9.2	4,720.6	806.0	363.0	684.0	117.0	35.0	7,280.0	9,323.0	75,983.0	901
Apr. 93	82,862.0	9.3	4,392.6	701.0	462.0	495.0	120.0	39.0	4,160.0	7,022.0	62,280.0	659
May 93	79,146.0	9.4	4,180.9	671.0	462.0	462.0	105.0	33.0	9,360.0	11,692.0	57,611.0	657
Jun. 93	68,480.0	9.6	3,508.5	548.0	594.0	363.0	117.0	33.0	18,300.0	6,971.0	58,734.0	667
Jul. 93	91,788.0	10.1	4,492.3	1,053.0	495.0	561.0	122.0	30.0	8,320.0	18,223.0	87,087.0	878
Aug. 93	78,528.0	9.4	4,121.9	927.0	726.0	198.0	119.0	50.0	2,080.0	8,802.0	74,643.0	861
Sep. 93	76,122.0	9.3	4,029.5	987.0	462.0	363.0	118.0	27.0	2,080.0	10,587.0	62,690.0	710
Oct. 93	85,538.0	9.5	4,430.7	968.0	462.0	396.0	114.0	40.0	6,240.0	9,996.0	58,347.0	736
Nov. 93	79,876.0	9.5	4,158.0	800.5	396.0	330.0	143.0	36.0	16,640.0	16,347.0	61,650.0	766
Dec. 93	86,196.0	10.9	3,914.5	929.0	330.0	528.0	171.0	44.0	7,500.0	9,364.0	37,161.0	517
TOTALS	1,000,304.0	9.7	51,653.9	10,150.5	5,313.0	5,747.0	1,574.0	456.0	96,520.0	118,187.0	802,459.0	9,083
AVERAGE	83,358.7	9.6	4,304.5	845.9	442.8	478.9	131.2	38.0	8,043.3	9,848.9	66,871.6	756
Jan. 94	87,958.0	9.0	4,860.2	785.0	231.0	775.0	140.0	48.0	2,520.0	23,110.0	6,525.0	292
Feb. 94	57,326.0	9.4	3,027.1	698.0	400.0	231.0	109.0	29.0	14,000.0		10,588.0	108
Mar. 94	75,534.0	9.8	3,836.5	733.0	495.0	198.0	102.0	30.0	11,440.0	8,342.0		
Apr. 94	62,478.0	9.8	3,179.0	618.0	429.0	231.0	119.0	32.0	10,640.0	3,301.0		
May 94	60,546.0	9.8	3,102.3	522.0	348.0	242.0	105.0	80.0	4,960.0	10,960.0		
Jun. 94	51,624.0	10.0	2,578.8	457.0		512.0	96.0	38.0	4,220.0	11,314.0		
Jul. 94	49,674.0	10.4	2,397.1	481.0		482.0	92.0		7,220.0	20,889.0		
Aug. 94	51,806.0	9.9	2,615.9	427.0		479.0	91.0	30.0	10,400.0			
Sep. 94	46,974.0	9.3	2,534.2	474.0		462.0	74.0	38.0	21,080.0	21,028.0		
Oct. 94	49,238.0	9.8	2,512.2	591.0		561.0	106.0	44.0	2,040.0	1,159.0		
Nov. 94	53,494.0	10.1	2,649.9	534.0		528.0	85.0	59.0	5,200.0	8,068.0		
Dec. 94	49,050.0	10.2	2,400.3	410.0	66.0	462.0	72.0	60.0	7,320.0	24,413.0		
TOTALS	695,702.0	9.7	35,693.5	6,730.0	1,969.0	5,163.0	1,191.0	488.0	101,040.0	132,584.0	17,113.0	401.
AVERAGE	57,975.2	9.8	2,974.5	560.8	328.2	430.3	99.3	44.4	8,420.0	13,258.4	8,556.5	200.

AREA A MONTHLY USAGE AND PRODUCTION REPORT

an-95

Month	Filtered Water Produced (K Gals.)	River Water Produced (K Gals.)	Chlorine (Lbs.)	Aluminum Sulfate (Lbs.)	Hydrated Lime (Lbs.)	Caustic Soda (Lbs.)	Waste Water Pumped (K Gals.)	Fuel Oil (Gals.)	Propane (Gals.)	Drinking Water (K Gals.)	City Sewage Treated (K Gals.)	Ele cit (K
Jan. 92	47,258.0	577,776.0	118.0	5,600.0		56,566.0	14,450.0 *			930.5	930.5	
Feb. 92	53,507.0	549,312.0	95.0	6,100.0		59,347.0	15,780.0 *		150.0	409.1	409.1	
Mar. 92	47,418.0	613,338.0	126.0	7,050.0		51,082.0	15,640.0 *		100.0	334.1	334.1	1
Apr. 92	46,571.0	595,695.0	101.0	6,400.0		41,462.0	16,120.0 *			602.9	602.9	
May 92	44,382.0	551,340.0	106.0	6,600.0		57,289.0	16,196.0 *		134.3	187.0	187.0	
Jun. 92	41,631.0	538,380.0	92.0	5,700.0		35,651.0	15,920.0 *		155.0	230.8	230.8	1
Jul. 92	57,653.0	550,866.0	141.0	6,550.0	1,400.0	36,536.0	16,430.0 *		50.0	239.7	239.7	1
Aug. 92	53,129.0	600,906.0	111.0	6,450.0	400.0	52,636.0	17,614.0 *		50.0	177.2	177.2	1
Sep. 92	43,154.0	581,703.0	87.0	5,650.0		51,749.0	18,204.0 *		75.0	196.9	196.9	
Oct. 92	46,122.0	621,540.0	105.0	6,550.0		53,017.0	16,900.0 *		95.0	331.7	331.7	1
Nov. 92	46,995.0	565,722.0	86.0	6,150.0	50.0	21,487.0	19,400.0 *	197.0		394.7	394.7	1
Dec. 92	50,379.0	573,690.0	106.0	6,400.0	450.0	39,199.0	18,760.0 *	182.0	68.0	325.9	325.9	
TOTALS	578,199.0	6,920,268.0	1,274.0	75,200.0	2,300.0	556,021.0	201,414.0 *	379.0	877.3	4,360.5	4,360.5	11
AVERAGE	48,183.3	576,689.0	106.2	6,266.7	575.0	46,335.1	16,784.5 *	189.5	97.5	363.4	363.4	
Jan. 93	49,308.0	594,855.0	102.0	6,950.0	1,000.0	111,462.0	17,337.0 *	138.0	65.0	321.8	321.8	
Feb. 93	43,342.0	523,392.0	93.0	5,900.0	300.0	97,796.0	19,145.0 *	224.0	30.0	345.4	345.4	
Mar. 93	51,108.0	570,264.0	109.0	7,600.0	350.0	60,260.0	25,763.0	104.0	155.0	375.4	375.4	1.
Apr. 93	48,552.0	585,066.0	105.0	6,600.0	350.0	39,796.0	23,073.0	26.0		450.0	450.0	
May 93	47,880.0	620,970.0	115.0	6,450.0	350.0	53,782.0	23,234.0	18.0		361.2	361.2	1.
Jun. 93	45,653.0	598,032.0	111.0	5,250.0	250.0	83,718.0	23,604.0		175.2	265.4	265.4	
Jul. 93	47,284.0	693,060.0	117.0	5,600.0	650.0	98,570.0	24,452.0			267.5	265.4	1,
Aug. 93	47,633.0	624,960.0	123.0	5,850.0	500.0	35,549.0	22,843.0			345.9	345.9	
Sep. 93	43,568.0	604,800.0	139.0	5,550.0	500.0	37,112.0	19,102.0		25.0	345.6	345.6	1,
Oct. 93	48,610.0	639,867.0		5,250.0	500.0	47,598.0	21,264.0			370.6	370.6	1,
Nov. 93	46,145.0	627,030.0		5,750.0	450.0	26,742.0	19,323.0		10.0	397.7	397.7	
Dec. 93	48,924.0	644,697.0		7,050.0		38,848.0	21,849.0		59.9	499.7	499.7	
TOTALS	568,007.0	7,326,993.0	1,014.0	73,800.0	5,200.0	731,233.0	260,989.0	510.0	520.1	4,346.2	4,344.1	11,
AVERAGE	47,333.9	610,582.8	112.7	6,150.0	472.7	60,936.1	21,749.1	102.0	74.3	362.2	362.0	[illegible]
Jan. 94	50,300.0	639,306.0	.0	10,550.0		73,960.0	22,488.0	.0	25.0	644.9	644.9	
Feb. 94	39,696.0	564,480.0	.0	6,050.0	150.0	55,270.0	19,804.0	.0	125.0	823.6	823.6	[illegible]
Mar. 94	43,723.0	624,960.0	.0	7,400.0		81,616.0	21,674.0	.0		548.6	548.6	1,
Apr. 94	40,687.0	599,130.0	.0	7,300.0		35,080.0	19,283.0	.0		581.9	581.9	[illegible]
May 94	41,304.0	613,248.0	.0	4,300.0		35,297.0	20,726.0	.0	5.0	567.2	567.2	[illegible]
Jun. 94	37,263.0	603,624.0	.0	5,350.0		46,352.0	17,886.0	.0		627.7	627.7	[illegible]
Jul. 94	39,624.0	624,960.0	.0	7,300.0		33,083.0	16,685.0	.0		496.4	496.4	[illegible]
Aug. 94	42,257.0	527,520.0	.0	5,200.0	450.0	56,917.0	15,087.0	.0		483.5	483.5	[illegible]
Sep. 94	34,361.0	604,758.0	.0	6,300.0		33,083.0	13,130.0	.0		533.7	533.7	1,
Oct. 94	36,547.0	625,800.0	.0	5,600.0		33,565.0	12,525.0	.0		551.6	551.6	[illegible]
Nov. 94	35,920.0	584,640.0	.0	5,250.0		20,661.0	9,833.0			674.5	674.5	[illegible]
Dec. 94	37,857.0	624,960.0	.0	5,600.0		10,834.0	10,679.0			674.7	674.7	[illegible]
TOTALS	479,539.0	7,237,386.0	.0	76,200.0	600.0	515,718.0	199,800.0	.0	155.0	7,208.3	7,208.3	11,
AVERAGE	39,961.6	603,115.5	.0	6,350.0	300.0	42,976.5	16,650.0	.0	51.7	600.7	600.7	[illegible]

AREA A MONTHLY REPORT

	Month	Steam Produced (K Lbs.)	Evaporation Rate (%)	A-8 Coal (Tons)	A-10 E Product Coal (Tons)	Refrigeration (Tons)	Air Compressor (K Cu.Ft.)	Fuel Oil (Gals.)	Propane (Gals.)	Electricity (K KW Hrs.)
	Jan. 89	82265.0	10.3	3899.3	1276.5	10537.0	10537.0	0.0	75.0	928.0
	Feb. 89	79568.0	10.5	3721.7	1056.3	9293.0	9293.0	0.0	60.0	826.0
	Mar. 89	74790.0	10.4	3523.9	1289.4	10719.0	10719.0	0.0	35.0	955.0
	Apr. 89	75460.0	10.6	3481.2	1200.7	10730.0	10730.0	0.0	10.0	929.0
	May 89	81340.0	9.9	4012.1	911.2	12063.0	12063.0	0.0	25.0	795.0
1989	Jun. 89	80244.0	10.3	3814.3	1347.5	10937.0	10937.0	0.0	50.0	981.0
	Jul. 89	71130.0	8.3	4179.5	1200.5	11497.0	11497.0	0.0	25.0	1091.0
	Aug. 89	74052.0	10.3	3537.2	1036.9	11587.0	11587.0	0.0	0.0	1268.0
	Sep. 89	78650.0	10.9	3179.0	1003.5	11736.0	11736.0	0.0	50.0	1060.0
	Oct. 89	75686.0	10.6	3482.7	1234.6	11540.0	11540.0	0.0	75.0	991.0
	Nov. 89	84564.0	10.2	4067.7	1030.7	11556.0	11556.0	0.0	6.2	934.0
	Dec. 89	79732.0	9.1	4291.6	906.7	11377.0	11377.0	0.0	10.0	892.0
	TOTALS	929481.0	10.28	45190.2	13494.5	133572.0	133572.0	0.0	421.2	11658.0
	Jan. 90	85476.0	10.1	4139.9	1152.2	3314.9	9992.0	0.0	60.0	917.0
	Feb. 90	66780.0	10.3	3176.2	857.9	2866.8	9202.0	0.0	0.0	1010.0
	Mar. 90	78148.0	10.5	3646.7	1297.2	3921.8	10320.0	0.0	65.0	967.0
	Apr. 90	75362.0	10.4	3562.1	1086.8	3875.6	9847.0	0.0	20.0	1109.0
1990	May 90	73356.0	11.0	3341.9	1102.3	4208.9	12912.0	0.0	25.0	894.0
	Jun. 90	81552.0	10.3	3855.9	1199.5	4690.5	10850.0	0.0	45.0	691.0
	Jul. 90	59107.0	10.7	2751.3	993.6	4442.4	11447.9	0.0	164.0	978.0
	Aug. 90	83342.0	10.7	3826.7	1076.9	4953.4	11795.0	0.0	0.0	686.0
	Sep. 90	77218.0	9.7	3883.9	1154.0	4036.0	11228.0	0.0	0.0	830.0
	Oct. 90	77972.0	10.8	3537.9	1117.8	3697.6	11779.0	10480.0	0.0	852.0
	Nov. 90	77890.0	10.2	3745.9	989.6	2597.8	11315.0	0.0	50.0	724.0
	Dec. 90	97596.0	11.5	4185.3	1130.0	2929.4	11855.0	0.0	10.0	641.2
	TOTALS	933799.0	10.70	43653.6	13157.8	45535.1	132537.0	10480.0	439.0	10359.0
	Jan. 91	90002.0	10.16	4466.8	1036.7	2544.2	11987.0	0.0	0.0	616.0
	Feb. 91	73648.0	10.21	3608.2	942.7	2280.1	10923.0	0.0	140.0	640.0
	Mar. 91	79624.0	10.48	3797.6	1206.9	2779.2	11154.0	[illegible]	13.7	651.0
	Apr. 91	79848.0	10.17	3885.5	1089.8	3029.6	10721.0	0.0	0.0	949.0
1991	May 91	84754.0	10.49	4040.0	1096.3	2985.3	11892.0	0.0	0.0	762.0
	Jun. 91	70156.0	10.23	3429.3	890.0	2298.0	11833.0	0.0	120.0	1046.0
	Jul. 91	77782.0	10.04	3871.9	844.3	2261.2	11487.0	0.0	0.0	1310.0
	Aug. 91	85282.0	10.37	4034.5	1123.5	3159.0	13727.0	0.0	130.0	1202.0
	Sep. 91	79226.0	10.10	3842.5	1091.2	2923.6	11575.0	0.0	0.0	1039.0
	Oct. 91	82330.0	10.40	3893.5	916.4	2606.9	11121.0	0.0	15.0	1049.0
	Nov. 91									
	Dec. 91									
	TOTALS	802652.0	10.32	38869.8	10238.2	26787.1	116420.0	0.0	418.7	9273.0
	Jan. 92	89.572.0	10.1	4,369.3	1,147.0	2,806.6	10,622.0			841.0
	Feb. 92	79,422.0	9.9	3,919.2	1,079.7	2,636.3	9,890.0		150.0	894.0
	Mar. 92	92.748.0	9.8	4.644.0	1,313.9	3,591.0	11,094.0		100.0	1,075.0
	Apr. 92	81,590.0	9.4	4,229.0	1,189.1	2,755.4	11,212.0			889.0
1992	May 92	84,530.0	9.0	4,591.1	1,038.8	2,978.6	11,191.0		134.3	999.0
	Jun. 92	62,588.0	10.1	3,050.4	759.8	2,141.8	9,820.0		155.0	1,061.0
	Jul. 92	83,096.0	9.6	4,257.0	1,166.9	3,506.5	11,031.0		50.0	1,062.0
	Aug. 92	81,898.0	9.6	4,191.1	1,035.5	3,140.0	11,450.0		50.0	1,017.0
	Sep. 92	87,044.0	9.7	4,431.1	907.4	3,004.3	10,253.0		75.0	800.0
	Oct. 92	79,438.0	9.6	4,051.2	1,001.5	2,657.5	9,826.0		95.0	1,163.0
	Nov. 92	76,005.0	9.1	4.131.4	695.7	2,020.0	10,619.0	197.0		1,164.0
	Dec. 92	90,986.0	9.4	4,762.6	996.5	2,429.4	11,843.0	182.0	68.0	854.0
	TOTALS	988,917.0	9.8	50,627.4	12,331.7	33,667.4	128,851.0	.0	877.3	11,819.0
	Jan. 93	100,650.0	9.2	5,376.2	1,041.3	2,819.1	10,331.0	138.0	65.0	946.0
	Feb. 93	83,448.0	9.5	4,328.2	685.9	1,895.7	9,980.0	224.0	30.0	956.0
	Mar. 93	87,670.0	9.2	4,720.6	901.8	2,046.2	11,517.0	104.0	155.0	1,087.0
	Apr. 93	82,862.0	9.3	4,392.6	659.5	1,670.1	10,458.0	26.0		957.0
1993	May 93	79,146.0	9.4	4,180.9	657.1	1,918.0	10,940.0	18.0		1,010.0
	Jun. 93	68,480.0	9.6	3,508.5	667.0	2,538.8	11,473.0		175.2	984.0
	Jul. 93	91,788.0	10.1	4,492.3	878.5	3,275.1	11,903.0			1,098.0
	Aug. 93	78,528.0	9.4	4,121.9	861.7	2,795.8	11,636.0			985.0
	Sep. 93	76,122.0	9.3	4,029.5	710.5	2,693.9	12,215.0		25.0	1,075.0
	Oct. 93	85,538.0	9.5	4,430.7	736.1	2,248.9	13,108.0			1,002.0
	Nov. 93	79,876.0	9.5	4,158.0	766.8	1,750.6	12,583.0		10.0	809.0
	Dec. 93	86,196.0	10.9	3,914.5	517.3	2,255.0	12,895.0		59.9	928.0
	TOTALS	1,000,304.0	9.7	51,653.9	9,083.4	27,907.1	139,039.0	510.0	520.1	11,837.0
	Jan. 94	87,958.0	9.0	4,860.2	292.7	1,801.2	12,863.0	.0	25.0	965.0
	Feb. 94	57,326.0	9.4	3,027.1	108.3	431.3	11,306.0	.0	125.0	934.0
94	Mar. 94	75,534.0	9.8	3,836.5		1,960.2	12,588.0	.0		1,084.0
	Apr. 94	62,478.0	9.8	3,179.0		1,958.2	10,637.0	.0		950.0
	May 94	60,546.0	9.8	3,102.3		2,039.8	10,772.0	.0	5.0	847.0
	Jun. 94	51,624.0	10.0	2,578.8		1,609.8	9,959.0	.0		906.0
	Jul. 94	49,674.0	10.4	2,397.1		2,264.7	9,759.0	.0		950.0
	Aug. 94	51,806.0	9.9	2.615.9		1,971.1	9.834.0	.0		960.0
	Sep 94	46,974.	9.3	2,534.2		1,641.5	9,226.0			1,012.0
	Totals	543,920	9.7	28,130.9	400.9	15,677.7	96.944		155.0	8,608.0

77457 K/MO

Appendix 3 - Scope of Work

DEPARTMENT OF THE ARMY
MOBILE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 2288-0001
Mobile, Alabama 36628-0001
22 June 1995

REPLY TO
ATTENTION OF:
Architect-Engineer Contracts Section

RECEIVED
Affiliated Engineers SE, Inc.
JUN 26 1995
Route to CD 6/26/95
CC: RB

Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, Florida 32608

Dear Mr. Miller:

Reference is made to Contract Number DACA01-94-D-0007, Delivery Order Number 003, for a Limited Energy Study for the Area A Package Boiler at Holston Army Ammunition Plant, TN.

We propose to modify referenced delivery order to provide for additional inspection effort in accordance with the enclosed Scope of Work..

Your are requested to prepare your fee proposal for accomplishing the additional work resulting from this change in sufficient detail to permit analysis thereof and submit it by 28 June 1995. Your proposal should be addressed as follows:

District Engineer
U.S. Army Engineer District, Mobile
Attention: CESAM-EN-M/Mr. Dan Mizelle
Post Office Box 2288
Mobile, Alabama 36628-0001

You are cautioned that no work or services for which an additional cost or fee will be charged should be furnished without the prior written authorization of the Contracting Officer.

If you have any questions concerning the work requirements, please contact Mr. Bill McClelland at telephone 334/441-6444.

Sincerely,

O. B. Anderson
Authorized Representative
of the Contracting Officer

Enclosure

CESAM-EN-DM 20 Jun 95

FY95 LIMITED ENERGY STUDY, AREA A PACKAGE BOILER
HOLSTON ARMY AMMUNITION PLANT, TENNESSEE

MINIMUM REQUIREMENTS FOR INSPECTION OF EXISTING BOILERS
AT
VOLUNTEER ARMY AMMUNITION PLANT, TENNESSEE

1. Open all manway covers of both boilers and all handhole plates. Remove all internals to expose tube ends in steam drum. Open access to furnace area including base of chimney.

2. Perform in-depth visual internal and external inspection of the boilers to identify any condition that may affect the integrity of the pressure retaining components.

3. Remote Field Eddy Current (RFEC) testing of 25 percent of the boiler tubes to determine the amount of thinning that may have occurred during the life of the boiler. Each boiler has approximately one thousand 2-inch tubes. The inspector will determine which tubes to test.

4. Ultrasonic thickness measurements of shell and heads to identify any loss of thickness due to corrosion.

5. Ultrasonic thickness testing of the 2.75-inch membrane-attached tubes to identify any thinning that may have occurred.

6. Perform calculations to determine allowable operating pressure based on the obtained thicknesses, and compare with original design pressure of 375 psi at 442^{o}F.

7. Provide labor and materials to replace gaskets for all manholes, handholes, and items removed for inspection prior to hydrostatic testing. Provide necessary blind flanges and gaskets on steam outlet to perform hydrostatic test.

8. Perform a hydrostatic test of each boiler to identify any abnormal condition not previously identified by other testing. Conduct the hydrostatic test at a pressure to be determined, based on the calculations for the shell, heads, and tubes, but not to exceed 150 percent of the original design pressure.

9. After hydrostatic testing is complete, drain boiler and dry internal parts in preparation for returning boiler to a lay-up condition.

10. Provide labor and material to replace desiccant in preparation for returning boilers to a lay-up condition. Closing of boilers will be the responsibility of the inspecting agency.

Encl 1, pg 1

11. Provide three spiral-bound copies of a detailed report on the conditions noted, results of all testing and inspections, including a color-coded tube layout diagram indicating the current thickness of all tubes examined with RFEC, calculations to verify the current maximum allowable working pressure of the tubes, shells and heads, recommendations to restore the boilers to a safe and reliable condition, a projected remaining useful life, and photographs, if required. Report to be delivered to AE not later than two weeks after testing is completed.

TASKS TO BE PERFORMED BY VOLUNTEER AAP PERSONNEL

1. Provide electrical power and water to building. Provide piping to boilers for hydrostatic test and means to drain boiler water after test.

2. Provide one copy of all prints and manufacturer's documents for the boilers to the inspecting group five working days prior to the scheduled inspection/testing, to be returned with the delivery of the final testing and inspection report to the AE.

3. Inspect boilers after all testing and inspections are complete to verify internals are dry prior to closure.

CESAM-EN-DM

27 January 1995
Revised 3 March 1995

SCOPE OF WORK

FOR A

LIMITED ENERGY STUDY

AREA A PACKAGE BOILER

HOLSTON ARMY AMMUNITION PLANT, TN

Performed as part of the

ENERGY ENGINEERING ANALYSIS PROGRAM (EEAP)

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encl 4

SCOPE OF WORK
FOR A
LIMITED ENERGY STUDY

AREA A PACKAGE BOILER
HOLSTON ARMY AMMUNITION PLANT, TN

TABLE OF CONTENTS

ANNEXES

1. <u>BRIEF</u> <u>DESCRIPTION</u> <u>OF</u> <u>WORK</u>: The Architect-Engineer (AE) shall:

1.1 Review the previously completed Energy Engineering Analysis Program (EEAP) study which applies to the specific building, system, or energy conservation opportunity (ECO) covered by this study.

1.2 Perform a limited site survey of specific buildings or areas to collect all data required to evaluate the specific ECOs included in this study.

1.3 Evaluate specific ECOs to determine their energy savings potential and economic feasibility.

1.4 Provide project documentation for recommended ECOs as detailed herein.

1.5 Prepare a comprehensive report to document all work performed, the results and all recommendations.

2. <u>GENERAL</u>

2.1 This study is limited to the evaluation of the specific buildings, systems, or ECOs listed in Annex A, DETAILED SCOPE OF WORK.

2.2 The information and analysis outlined herein are considered to be minimum requirements for adequate performance of this study.

2.3 For the buildings, systems or ECOs listed in Annex A, all methods of energy conservation which are reasonable and practical shall be considered, including improvements of operational methods and procedures as well as the physical facilities. All energy conservation opportunities which produce energy or dollar savings shall be documented in this report. Any energy conservation opportunity considered infeasible shall also be documented in the report with reasons for elimination.

2.4 The study shall consider the use of all energy sources applicable to each building, system, or ECO.

2.5 The "Energy Conservation Investment Program (ECIP) Guidance", described in letter from DAIM-FDF-U, dated 10 Jan 1994 establishes criteria for ECIP projects and shall be used for performing the economic analyses of <u>all</u> ECOs and projects. The program, Life Cycle Cost In Design (LCCID), has been developed for performing life cycle cost calculations in accordance with ECIP guidelines and is referenced in the ECIP Guidance. If any program other than LCCID is proposed for life cycle cost analysis, it must use the mode of calculation specified in the ECIP Guidance. The output must be in the format of the ECIP LCCA summary sheet, and it must be submitted for approval to the Contracting Officer.

2.6 The following definitions apply to terms used in this scope of work:

2.6.1 "Contracting Officer", "Contracting Officer's Representative", or Government's Representative" refer to the contracting office of the Mobile District, U. S. Army Corps of Engineers.

2.6.2 "Installation Commander", or "Installation Representative" refer to the military commander of Holston Army Ammunition Plant.

2.6.3 "Plant Manager", Operating Contractor", or "Operating Contractor's Representative" refer to the Holston Defense Corporation, which operates Holston Army Ammunition Plant under contract to the U. S. Army.

2.7 Energy conservation opportunities determined to be technically and economically feasible shall be developed into projects acceptable to installation personnel. This may involve combining similar ECOs into larger packages which will qualify for ECIP or O&M funding, and determining in coordination with installation personnel the appropriate packaging and implementation approach for all feasible ECOs.

2.7.1 Projects which qualify for ECIP funding shall be identified, separately listed, and prioritized by the Savings to Investment Ratio (SIR).

2.7.2 All feasible non-ECIP projects shall be ranked in order of highest to lowest SIR.

2.8 Metric Reporting Requirements: In this study, the analyses of the ECOs may be performed using English or Metric units as long as they are consistent throughout the report. The final results of energy savings for individual recommended projects and for the overall study will be reported in units of MegaBTU per year and in MegaWattHours per year. Paragraph 7.5.2 details requirements for the contents of the final submittal.

3. PROJECT MANAGEMENT

3.1 Project Managers. The AE shall designate a project manager to serve as a point of contact and liaison for work required under this contract. Upon award of this contract, the individual shall be immediately designated in writing. The AE's designated project manager shall be approved by the Contracting Officer prior to commencement of work. This designated individual shall be responsible for coordination of work required under this contract. The Contracting Officer will designate a project manager to serve as the Government's point of contact and liaison for all work required under this contract. This individual will be the Government's representative.

3.2 Installation Assistance.

a. The Installation Commander will designate an individual to coordinate between the AE and the Holston Defense Corporation. This individual will be the Installation Representative, and all correspondence with Holston Army Ammunition Plant will be addressed to his attention.

b. The Plant Manager will designate an individual to assist the AE in obtaining information and establishing contacts necessary to accomplish the work required under this contract. This individual will be the Operating Contractor's Representative.

3.3 Public Disclosures. The AE shall make no public announcements or disclosures relative to information contained or developed in this contract, except as authorized by the Contracting Officer.

3.4 Meetings. Meetings will be scheduled whenever requested by the AE or the Contracting Officer for the resolution of questions or problems encountered in the performance of the work. The AE's project manager and the Government's representative shall be required to attend and participate in all meetings pertinent to the work required under this contract as directed by the Contracting Officer. These meetings, if necessary, are in addition to the presentation and review conferences.

3.5 Site Visits, Inspections, and Investigations. The AE shall visit and inspect/investigate the site of the project as necessary and required during the preparation and accomplishment of the work.

3.6 Records

3.6.1 The AE shall provide a record of all significant conferences, meetings, discussions, verbal directions, telephone conversations, etc., with Government representative(s) relative to this contract in which the AE and/or designated representative(s) thereof participated. These records shall be dated and shall identify the contract number, delivery order number, participating personnel, subject discussed and conclusions reached. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the records.

3.6.2 The AE shall provide a record of requests for and/or receipt of Government-furnished material, data, documents, information, etc., which if not furnished in a timely manner, would significantly impair the normal progression of the work under this contract. The records shall be dated and shall identify the contract number and modification number, if applicable. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the record of request or receipt of material.

3.7 Interviews. The AE and the Government's representative shall conduct entry and exit interviews with the Plant Manager before starting work at the installation and after completion of the field work. The Government's representative shall schedule the interviews at least one week in advance.

3.7.1 Entry. The entry interview shall describe the intended procedures for the survey and shall be conducted prior to commencing work at the facility. As a minimum, the interview shall cover the following points:

a. Schedules.

b. Names of energy analysts who will be conducting the site survey.

c. Proposed working hours.

d. Support requirements from Holston Defense Corporation (HDC).

3.7.2 Exit. The exit interview shall briefly describe the items surveyed and probable areas of energy conservation. The interview shall also solicit input and advice from the Plant Manager.

4. SERVICES AND MATERIALS. All services, materials (except those specifically enumerated to be furnished by the Government), labor, supervision and travel necessary to perform the work and render the data required under this contract are included in the lump sum price of the contract.

5. PROJECT DOCUMENTATION. All energy conservation opportunities which the AE has considered shall be included in one of the following categories and presented in the report as such:

5.1 ECIP Projects. To qualify as an ECIP project, an ECO, or several ECOs which have been combined, must have a construction cost estimate greater than $300,000, a Savings to Investment Ratio (SIR) greater than 1.25 and a simple payback period of less than ten years. The overall project and each discrete part of the project shall have an SIR greater than 1.25. All projects meeting the above criteria shall be arranged as specified in paragraph 2.7.1 and shall be provided with programming documentation. Programming documentation shall consist of a DD Form 1391 and life cycle cost analysis (LCCA) summary sheet(s) (with necessary backup data to verify the numbers presented). A life cycle cost analysis summary sheet shall be developed for each ECO and for the overall project when more than one ECO are combined. The energy savings for projects consisting of multiple ECOs must take into account the synergistic effects of the individual ECOs.

5.2 Non-ECIP Projects. Projects which do not meet ECIP criteria with regard to cost estimate or payback period, but which have an SIR greater than 1.25 shall be documented. Projects or ECOs in this category shall be arranged as specified in paragraph 2.7.2 and shall be provided with the following documentation: the life cycle cost analysis (LCCA) summary sheet completely filled out, a description of the work to be accomplished, backup data for the LCCA, ie, energy savings calculations and cost estimate(s), and the simple payback period. The energy savings for projects consisting of multiple ECOs must take into account the synergistic effects of the individual ECOs. In addition these projects shall have the necessary documentation prepared, as required by the Government's representative, for one of the following categories:

a. Federal Energy Management Program (FEMP) Projects. A FEMP (or O&M Energy) project is one that results in needed maintenance or repair to an existing facility, or replaces a failed or failing existing facility, and also results in energy savings. The criteria are similar to the criteria for ECIP projects, ie, SIR $\geq$ 1.25, and simple payback period of less than ten years. Projects with a construction cost estimate up to $1,000,000 shall be documented as outlined in par 5.2 above; projects over $1,000,000 shall be documented on 1391s. In the FEMP program, a system may be defined as "failed or failing" if it is inefficient or technically obsolete. However, if this strategy is used to justify a proposed project, the equipment to be replaced must have been in use for at least three years.

b. Low Cost/No Cost Projects. These are projects which the Plant Manager can perform using his resources. Documentation shall be as required by the Plant Manager.

5.3 Nonfeasible ECOs. All ECOs which the AE has considered but which are not feasible, shall be documented in the report with reasons and justifications showing why they were rejected.

6. DETAILED SCOPE OF WORK. See Annex A.

7. WORK TO BE ACCOMPLISHED.

7.1 Review Previous Studies. Review the previous EEAP study which applies to the specific building, system, or ECO covered by this study. This review should acquaint the AE with the work that has been performed previously. Much of the information the AE may need to develop the ECOs in this study may be contained in the previous study.

7.2 Perform a Limited Site Survey. The AE shall obtain all necessary data to evaluate the ECOs or projects by conducting a site survey. However, the AE is encouraged to use any data that may have been documented in a previous study. The AE shall document his site survey on forms developed for the survey, or standard forms, and submit these completed forms as part of the report. All test and/or measurement equipment shall be properly calibrated prior to its use.

7.3 Evaluate Selected ECOs. The AE shall analyze the ECOs listed in Annex A. These ECOs shall be analyzed in detail to determine their feasibility. Savings to Investment Ratios (SIRs) shall be determined using current ECIP guidance. The AE shall provide all data and calculations needed to support the recommended ECO. All assumptions and engineering equations shall be clearly stated. Calculations shall be prepared showing how all numbers in the ECO were figured. Calculations shall be an orderly step-by-step progression from the first assumption to the final number. Descriptions of the products, manufacturers catalog cuts, pertinent drawings and sketches shall also be included. A life cycle cost analysis summary sheet shall be prepared for each ECO and included as part of the supporting data.

7.4 Combine ECOs Into Recommended Projects. During the Interim Review Conference, as outlined in paragraph 7.5.1, the AE will be advised of the Plant Manager's preferred packaging of recommended ECOs into projects for implementation. Some projects may be a combination of several ECOs, and others may contain only one. These projects will be evaluated and arranged as outlined in paragraphs 5.1, 5.2, and 5.3. Energy savings calculations shall take into account the synergistic effects of multiple ECOs within a project and the effects of one project upon another. The results of this effort will be reported in the Final Submittal per par 7.5.2.

7.5 Submittals, Presentations and Reviews. The work accomplished shall be fully documented by a comprehensive report. The report shall have a table of contents and shall be indexed. Tabs and dividers shall clearly and distinctly divide sections, subsections, and appendices. All pages shall be numbered. Names of the persons primarily responsible for the project shall be included. The AE shall give a formal presentation of the interim submittal to installation, command, and other Government personnel. Slides or view graphs showing the results of the study to date shall be used during the presentation. During the presentation, the personnel in attendance shall be given ample opportunity to ask questions and discuss any changes deemed necessary to the study. A review conference will be conducted the same day, following the presentation. Each comment presented at the review conference will be discussed and resolved or action items assigned. It is anticipated that the presentation and review conference will require approximately one working day. The presentation and review conference will be at the installation on the date agreeable to the Plant Manager, the AE and the Government's representative. The Contracting Officer may require a resubmittal of any document(s), if such document(s) are not approved because they are determined by the Contracting Officer to be inadequate for the intended purpose.

7.5.1 Interim Submittal. An interim report shall be submitted for review after the field survey has been completed and an analysis has been performed on all of the ECOs. The report shall indicate the work which has been accomplished to date, illustrate the methods and justifications of the approaches taken and contain

a plan of the work remaining to complete the study. Calculations showing energy and dollar savings, SIR, and simple payback period of all the ECOs shall be included. The results of the ECO analyses shall be summarized by lists as follows:

a. All ECOs eliminated from consideration shall be grouped into one listing with reasons for their elimination as discussed in par 5.3.

b. All ECOs which were analyzed shall be grouped into two listings, recommended and non-recommended, each arranged in order of descending SIR. These lists may be subdivided by building or area as appropriate for the study. The AE shall submit the Scope of Work and any modifications to the Scope of Work as an appendix to the report. A narrative summary describing the work and results to date shall be a part of this submittal. At the Interim Submittal and Review Conference, the Government's and AE's representatives shall coordinate with the Plant Manager to provide the AE with direction for packaging or combining ECOs for programming purposes and also indicate the fiscal year for which the programming or implementation documentation shall be prepared. The survey forms completed during this audit shall be submitted with this report. The survey forms only may be submitted in final form with this submittal. They should be clearly marked at the time of submission that they are to be retained. They shall be bound in a standard three-ring binder which will allow repeated disassembly and reassembly of the material contained within.

7.5.2 Final Submittal. The AE shall prepare and submit the final report when all sections of the report are 100% complete and all comments from the interim submittal have been resolved. The AE shall submit the Scope of Work for the study and any modifications to the Scope of Work as an appendix to the submittal. The report shall contain a narrative summary of conclusions and recommendations, together with all raw and supporting data, methods used, and sources of information. The report shall integrate all aspects of the study. The recommended projects, as determined in accordance with paragraph 5, shall be presented in order of priority by SIR. The lists of ECOs specified in paragraph 7.5.1 shall also be included for continuity. The final report and all appendices shall be bound in standard three-ring binders which will allow repeated disassembly and reassembly. The final report shall be arranged to include:

a. An Executive Summary to give a brief overview of what was accomplished and the results of this study using graphs, tables and charts as much as possible (See Annex B for minimum requirements).

b. The narrative report describing the problem to be studied, the approach to be used, and the results of this study.

c. Documentation for the recommended projects (includes LCCA Summary Sheets).

d. Appendices to include as a minimum:

1) Energy cost development and backup data
2) Detailed calculations
3) Cost estimates
4) Computer printouts (where applicable)
5) Scope of Work

ANNEX A

DETAILED SCOPE OF WORK

1. The facility to be studied in this contract is the central steam plant for Area A at Holston Army Ammunition Plant (HSAAP) in Kingsport, Tennessee. Holston Army Ammunition Plant is a government-owned, contractor-operated (GOCO) facility. The operating contractor is the Holston Defense Corporation (HDC). For reasons of safety and security, access to the plant is controlled. Temporary passes will be required for both personnel and vehicle access. Some field work will also be required at Volunteer Army Ammunition Plant near Chattanooga, Tennessee.

a. A one-week notice should be given by the AE prior to any visit. This time will be needed to make the necessary arrangements for the visit.

b. The AE should submit a list of the equipment and instruments they plan to use prior to their arrival. Because of the nature of HSAAP operations, safety regulations prohibit and restrict the use of some equipment on the installation. Having a list of the equipment to be used beforehand, HSAAP will be better prepared at the entrance interview to address the regulations pertaining to the equipment to be used. This will also facilitate coordination of the inspection and permitting of the equipment.

2. The following persons have been designated as points of contact and liaison for all work required under this contract. Mr. Scott Shelton shall be the Installation Representative, and Mr. J. L. Bouchillon shall be the Operating Contractor's Representative.

3. Completion and Payment Schedule: The following schedule shall be used as a guide in approving payments on this contract. The final report for this study shall be due not later than 180 days after Notice to Proceed.

MILESTONE	PERCENT OF CONTRACT AMOUNT AUTHORIZED FOR PAYMENT
Completion of Field Work	25
Receipt of Interim Submittal	75
Completion of Interim Presentation & Review	85
Receipt of Final Report	100

4. Purpose and Background: The purpose of this study is to identify and evaluate the technical and economic feasibility of alternate methods of meeting the steam requirements of the Area A industrial complex. The Area A steam plant was constructed during World War II to serve an industrial complex that produces raw materials used in the manufacture of explosives. There are seven coal-fired boilers which generate steam at 400 psig and 575^{0}F. Each boiler has a full-load capacity of at least

100,000 pph. At current production levels, steam requirements can be met by using two boilers; sometimes only one is needed. Future production levels are projected to be even lower, requiring only one boiler to operate at part load. This method of operation would be very inefficient; therefore, HDC would like to evaluate other possibilities for meeting the steam needs of Area A. Following are some points which should be considered:

a. Evaluate using a pair of gas-fired package boilers of sufficient capacity at the existing plant. Location will be as directed by HDC; package boiler stacks will be tied into existing plant stack.

b. The process and heating needs of Area A are such that it would be preferable to use the existing distribution system rather than using multiple boilers at various sites.

c. Existing steam-driven chillers are being replaced with electric. This project should be complete by March 1996. For purposes of this study, assume the project to be complete.

d. There are two Babcock-Wilcox, natural-gas, packaged water-tube boilers laid away at Volunteer Army Ammunition Plant. They each have a capacity of 150,000 pph at 375 psig. They were installed in 1972, and were last used about 1980. A visual, external inspection was conducted in 1994; a copy of the report is furnished. Can these boilers be used at Area A? Would any repairs or modifications be needed? What would be the cost of relocating these boilers?

e. To what extent can the existing ancillary equipment (deaerator, feedwater heater, feedwater pumps, etc) in the plant be used with the package boilers? The boilers at Volunteer AAP include ancillary equipment. If these boilers are used, can their ancillary equipment be used also?

f. Maintenance and operations costs and savings must be included in the evaluation. One of the costs that must be considered is the cost to lay away existing Building 8-A if a gas-fired package boiler is recommended to replace the existing coal-fired boilers. HDC has written plans and procedures that must be followed for lay-away.

g. HDC currently pays an uninterruptible rate for natural gas due to process requirements; this is not likely to change. However, the package boilers should have dual-fuel (no.2 fuel oil) capability in the event of an emergency. Evaluate adequacy of current DF2 storage capacity, and include cost of additional storage if needed.

h. Determine changes that would have to be made to the existing air pollution operating permit for the addition of the package boilers, and include costs in evaluation.

i. Evaluate the possibility of using existing steam turbine drives to operate river water pumps which are presently electrically driven.

5. The boilers which are laid away at Volunteer Army Ammunition Plant must be inspected by a member of the National Board of Boiler and Pressure Vessel Inspectors to determine if they are suitable for the intended purpose and if any repairs or modifications will be needed.

6. Point of contact for entry to Volunteer Army Ammunition Plant is Mr. Jim Fry. Phone number (615) 855-7109.

7. An EEAP Limited Energy Study for Area A and Area B steam plants at HSAAP was completed by EMC Engineers, Inc. in August of 1992. The final report of this study includes a very good physical and operational description and a mathematical model of each plant. The AE is encouraged to read and use the information provided in this report.

8. Government-furnished information. The following documents will be furnished to the AE:

a. Final Report; LIMITED ENERGY STUDIES, HOLSTON ARMY AMMUNITION PLANT, KINGSPORT, TENNESSEE; August 1992; EMC Engineers, Inc.

b. MEMORANDUM, dated 5 October 1994, Subject: Trip Report T. A. 7881 - Volunteer Army Ammo Plant.

c. Energy Conservation Investment Program (ECIP) Guidance, dated 10 Jan 1994 and the latest revision with current energy prices and discount factors for life cycle cost analysis.

d. AR 420-49, Heating, Energy Selection and Fuel Storage, Distribution, and Dispensing Systems.

e. AR 415-15, 1 Jan 84, Military Construction, Army (MCA) Program Development

f. TM5-800-2, Cost Estimates, Military Construction.

g. Tri-Service Military Construction Program (MCP) Index, dated 13 February 1995.

h. Boiler plant logs for the Area A steam plant will be made available to the AE as needed.

9. A computer program titled Life Cycle Costing in Design (LCCID) is available from the BLAST Support Office in Urbana, Illinois for a nominal fee. This computer program can be used for performing the economic calculations for ECIP and non-ECIP ECOs. The AE is encouraged to obtain and use this computer program. The BLAST Support Office can be contacted at 144 Mechanical Engineering Building, 1206 West Green Street, Urbana,

Illinois 61801. The telephone number is (217) 333-3977 or (800) 842-5278.

10. Direct Distribution of Submittals. The AE shall make direct distribution of correspondence, minutes, report submittals, and responses to comments as indicated by the following schedule:

AGENCY	EXECUTIVE SUMMARIES	REPORTS	FIELD NOTES	CORRESPONDENCE
Commander Holston Army Ammunition Plant ATTN: SMCHO-EN (Mr Shelton) Kingsport, TN 37660-9982	3	3	1**	1
Commander U S AMC Installation and Service Activity ATTN: AMXEN-C (Mr Nache) Rock Island, IL, 61299-7190	1	1	-	-
Commander U. S. Army Corps of Engineers ATTN: CEMP-ET (Mr Gentil) 20 Massachusetts Avenue NW Washington, DC, 20314-1000	1*	-	-	-
Commander USAED, South Atlantic ATTN: CESAD-EN-TE (Mr Baggette) 77 Forsyth Street, SW Atlanta, GA 30335-6801	1	1	-	-
Commander USAED, Mobile ATTN: CESAM-EN-DM (Battaglia) PO Box 2288 Mobile, AL 36628-0001	2	2	1**	1
Commander U. S. Army Logistics Evaluation Agency ATTN: LOEA-PL (Mr Keath) New Cumberland Army Depot New Cumberland, PA, 17070 - 5007	1*	-	-	-

* Receives Executive Summary of final report only.
** Field Notes submitted in final form at interim submittal.

ANNEX B

EXECUTIVE SUMMARY GUIDELINE

1. Introduction.

2. Building Data (types, number of similar buildings, sizes, etc.)

3. Present Energy Consumption of Buildings or Systems Studied.

   o Total Annual Energy Used.

   o Source Energy Consumption.

Electricity	- KWH, Dollars, MBTU
Coal	- TONS, Dollars, MBTU, MWH
Natural Gas	- THERMS, Dollars, MBTU, MWH
Other	- QTY, Dollars, MBTU, MWH

4. Energy Conservation Analysis.

   o ECOs Investigated.

   o ECOs Recommended.

   o ECOs Rejected. (Provide economics or reasons)

   o ECIP Projects Developed. (Provide list)*

   o Non-ECIP Projects Developed. (Provide list)*

   o Operational or Policy Change Recommendations.

* Include the following data from the life cycle cost analysis summary sheet: the cost (construction plus SIOH), the annual energy savings (type and amount), the annual dollar savings, the SIR, the simple payback period and the analysis date.

6. Energy and Cost Savings.

   o Total Potential Energy Savings in MegaBTU per year (and MegaWattHr per year) and first year dollar savings.

   o Percentage of Energy Conserved.

   o Energy Use and Cost Before and After the Energy Conservation Opportunities are Implemented.

ANNEX C

REQUIRED DD FORM 1391 DATA

To facilitate ECIP project approval, the following supplemental data shall be provided:

a. In title block clearly identify projects as "ECIP."

b. Complete description of each item of work to be accomplished including quantity, square footage, etc.

c. A comprehensive list of buildings, zones, or areas including building numbers, square foot floor area, designated temporary or permanent, and usage (administration, patient treatment, etc.).

d. List references, and assumptions, and provide calculations to support dollar and energy savings, and indicate any added costs.

(1) If a specific building, zone, or area is used for sample calculations, identify building, zone or area, category, orientation, square footage, floor area, window and wall area for each exposure.

(2) Identify weather data source.

(3) Identify infiltration assumptions before and after improvements.

(4) Include source of expertise and demonstrate savings claimed. Identify any special or critical environmental conditions such as pressure relationships, exhaust or outside air quantities, temperatures, humidity, etc.

e. Claims for boiler efficiency improvements must identify data to support present properly adjusted boiler operation and future expected efficiency. If full replacement of boilers is indicated, explain rejection of alternatives such as replace burners, nonfunctioning controls, etc. Assessment of the complete existing installation is required to make accurate determinations of required retrofit actions.

f. Lighting retrofit projects must identify number and type of fixtures, and wattage of each fixture being deleted and installed. New lighting shall be only of the level to meet current criteria. Lamp changes in existing fixtures is not considered an ECIP type project.

g. An ECIP life cycle cost analysis summary sheet as shown in the ECIP Guidance shall be provided for the complete project and for each discrete part included in the project. The SIR is applicable to all segments of the project. Supporting documentation consisting of basic engineering and economic calculations showing how savings were determined shall be included.

h. The DD Form 1391 face sheet shall include, for the complete project, the annual dollar and MBTU (MWH) savings, SIR, simple amortization period and a statement attesting that all buildings and retrofit actions will be in active use throughout the amortization period.

i. The calendar year in which the cost was calculated shall be clearly shown on the DD Form 1391.

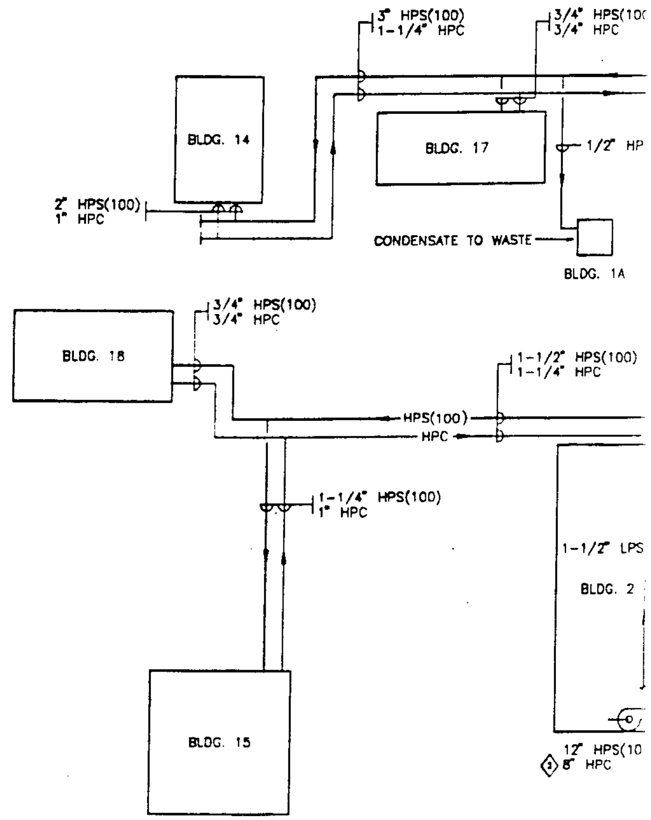
j. For each temporary building included in a project, separate documentation is required showing (1) a minimum 10-year continuing need, based on the installation's annual real property utilization survey, for active building retention after retrofit, (2) the specific retrofit action applicable and (3) an economic analysis supporting the specific retrofit.

k. Nonappropriated funded facilities will not be included in an ECIP project without an accompanying statement certifying that utility costs are not reimbursable.

l. Any requirements required by ECIP guidance dated 10 Jan 1994 and any revisions thereto. Note that unescalated costs/savings are to be used in the economic analyses.

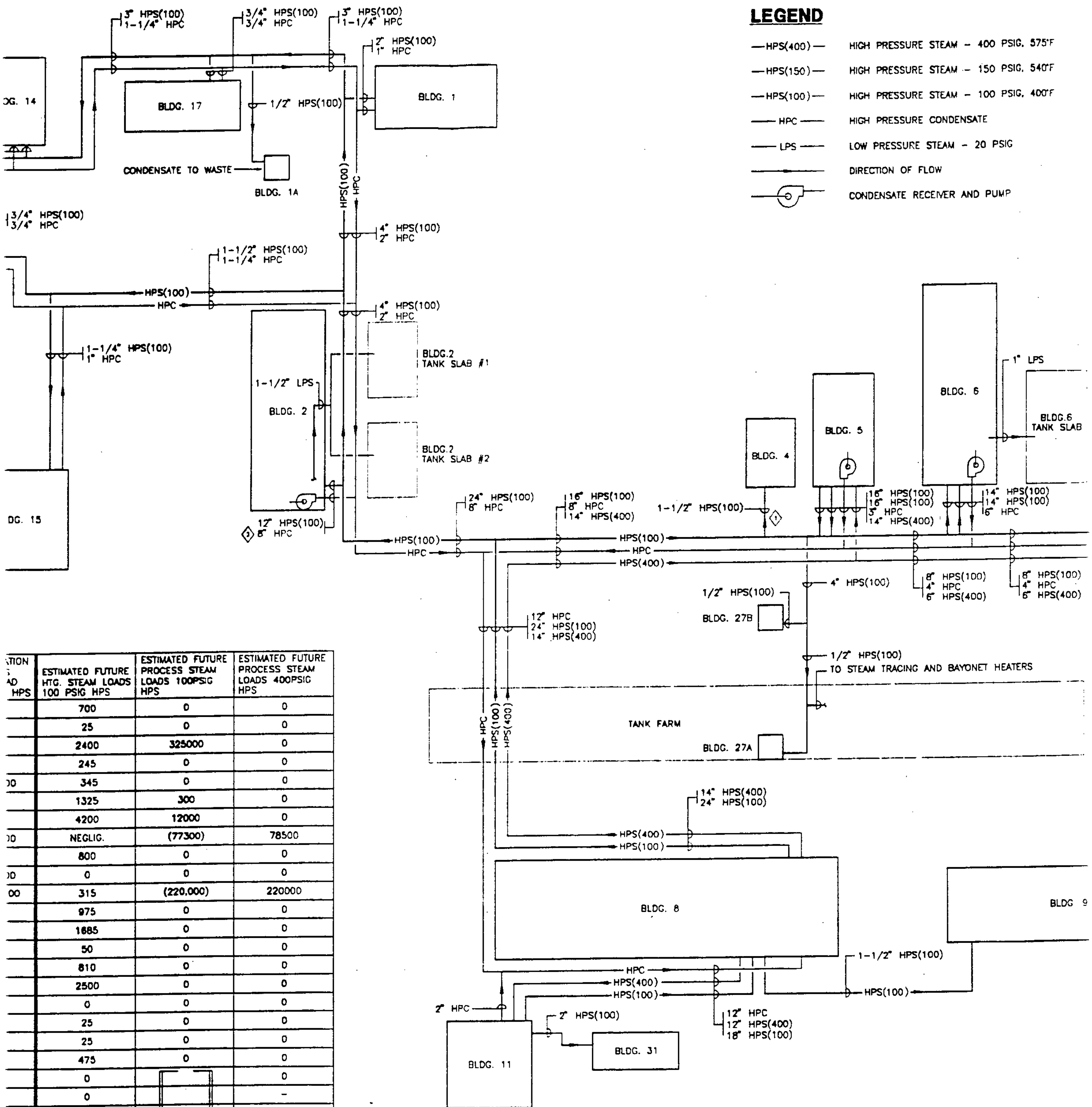
m. The five digit category number for all ECIP projects except for Family Housing is 80000. The category code number for Family Housing projects is 71100.

Appendix 4 - Drawings



DES. HTG STM. LD 100PSIG *	BLDG. NO.	BLDG. NAME	MOBILIZATION PROCESS STM. LOAD 100PSIG HPS	MOBILIZATION PROCESS STM. LOAD 400PSIG HPS	ESTIMATED FUTURE HTG. STEAM LOADS 100 PSIG HPS	ESTIMATED FUTURE PROCESS STEAM LOADS 100PSIG HPS	ESTIMATED FUTU PROCESS STEAM LOADS 400PSIG HPS
700	1	ADMINISTRATION	0	0	700	0	0
25	1A	GUARD HOUSE	0	0	25	0	0
2400	2	ACID CONCENTRATION BLDG.	325,000	0	2400	325000	0
245	4	ELECTRICAL INSTRUMENT SHOP	0	0	245	0	0
345	5	REFRIGERATION PLANT **	(87000)	87000	345	0	0
1325	6	ACETIC ANHYDRIDE REFINING	300	0	1325	300	0
4200	7	ACETIC ANHYDRIDE MANUF. BLDG.	12000	0	4200	12000	0
NEGLIG.	8	STEAM PLANT	(77300)	78500	NEGLIG.	(77300)	78500
800	9	WATER PLANT	0	0	800	0	0
VLVS. CL.	10	GAS PRODUCERS ***	0	24000	0	0	0
315	11	PUMP HOUSE	(220000)	220,000	315	(220,000)	220000
975	14	CHANGE HOUSE	0	0	975	0	0
1685	15	STOREHOUSE	0	0	1685	0	0
50	17	FIREHOUSE	0	0	50	0	0
810	18	RED CROSS BLDG.	0	0	810	0	0
2500	20	ACETIC ANHYDRIDE FURNACES	0	0	2500	0	0
0	21	CHANGE HOUSE	0	0	0	0	0
25	27A	OFFICE	0	0	25	0	0
25	27B	OFFICE	0	0	25	0	0
475	31	CHANGE HOUSE/SHOPS	0	0	475	0	0
0	-	BLDG. 2 TANK SLAB #1		0	0		0
0	-	BLDG. 2 TANK SLAB #2		0	0		-
0	-	BLDG. 6 TANK SLAB	39,100	0	0	39,100	-
0	-	TANK FARM		0	0		-
0	-	HEAT TRACING		0	0		-
16900	-	TOTAL HEATING	-	-	16900	-	-
		NET TOTAL PRODUCTION	(7900)	409500	-	79100	298500
		NET TOTAL STM RQD.	-	418500	-	-	394500

* HTG. ONLY BLDGS. ESTIMATED AT 125BTU/FT2; PROCESS BLDGS ESTIMATED AT 35BTU/FT2.
** ORIGINAL DESIGN INCLUDED BACK PRESSURE STEAM TURBINE DRIVEN REFRIGERATION COMPRESSORS WHICH HAVE BEEN (OR WILL BE) REPLACED BY ELECTRIC DRIVEN EQUIPMENT.
*** GAS PRODUCERS LAST USED IN FEB. 1994.



LEGEND

—HPS(400)—	HIGH PRESSURE STEAM – 400 PSIG, 575°F
—HPS(150)—	HIGH PRESSURE STEAM – 150 PSIG, 540°F
—HPS(100)—	HIGH PRESSURE STEAM – 100 PSIG, 400°F
—HPC—	HIGH PRESSURE CONDENSATE
—LPS—	LOW PRESSURE STEAM – 20 PSIG
———	DIRECTION OF FLOW
	CONDENSATE RECEIVER AND PUMP

...TION ... AD HPS	ESTIMATED FUTURE HTG. STEAM LOADS 100 PSIG HPS	ESTIMATED FUTURE PROCESS STEAM LOADS 100PSIG HPS	ESTIMATED FUTURE PROCESS STEAM LOADS 400PSIG HPS
	700	0	0
	25	0	0
	2400	325000	0
	245	0	0
)0	345	0	0
	1325	300	0
	4200	12000	0
)0	NEGLIG.	(77300)	78500
	800	0	0
)0	0	0	0
00	315	(220,000)	220000
	975	0	0
	1685	0	0
	50	0	0
	810	0	0
	2500	0	0
	0	0	0
	25	0	0
	25	0	0
	475	0	0
	0		0
	0		–
	0	39,100	–
	0		–
	0		–
	16900	–	–
,00	–	79100	298500
00	–	–	394500

) AT 35BTU/FT2.
:IGERATION
)RIVEN EQUIPMENT.

1 AREA 'A' STEAM & CONDENSATE DISTRIBUTION PIPING DIAGRAM

SCALE: NONE

NOTE:
THIS DWG. IS DIAGRAMMATIC IN NATURE AND DOES NOT SHOW EXPANSION LOOPS, STEAM TRAPS, ISOLATION VALVES, ACTUAL BUILDING SIZES, OR ACTUAL PIPE ROUTING.

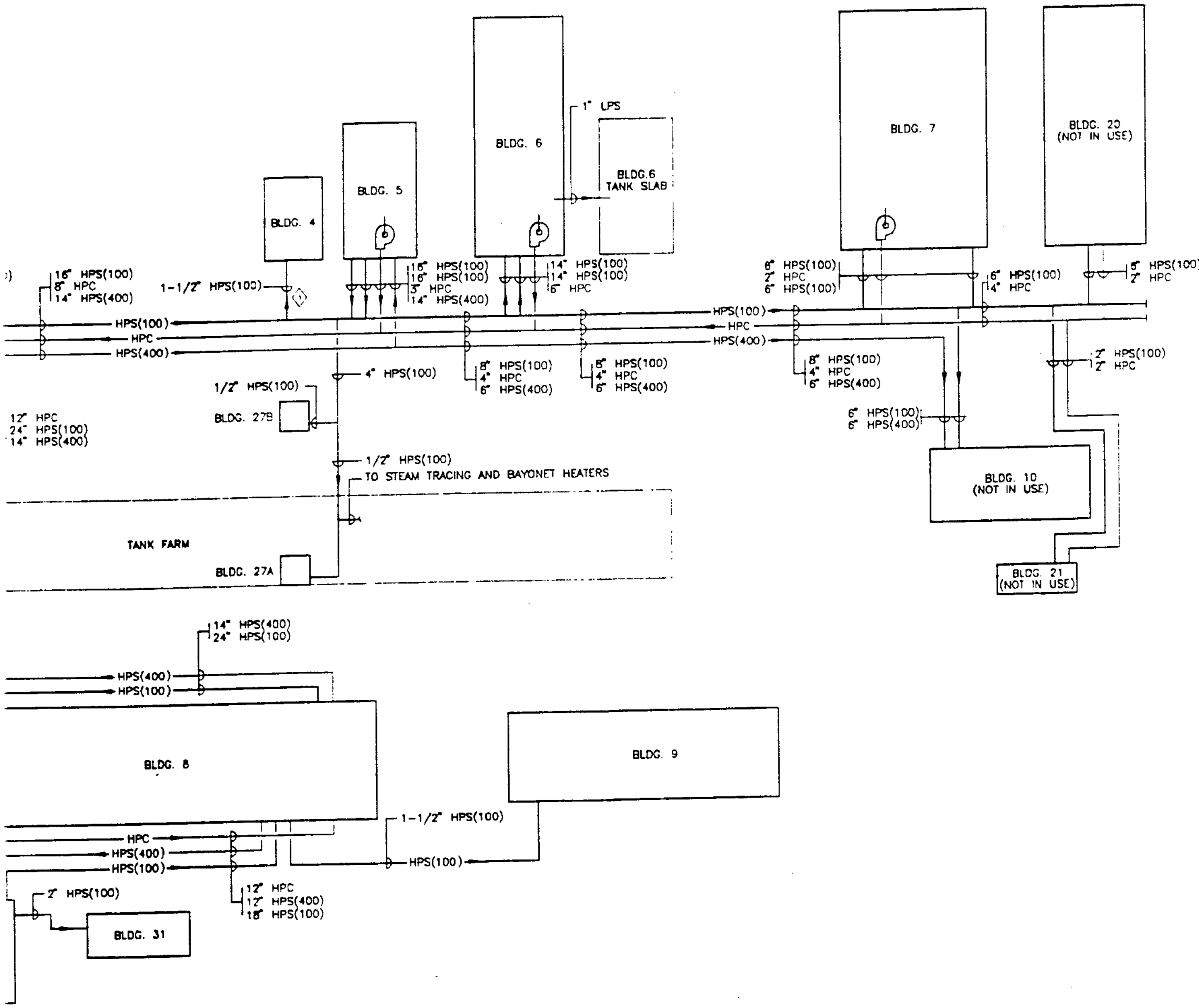
(2)

LEGEND

—HPS(400)—	HIGH PRESSURE STEAM – 400 PSIG, 575°F
—HPS(150)—	HIGH PRESSURE STEAM – 150 PSIG, 540°F
—HPS(100)—	HIGH PRESSURE STEAM – 100 PSIG, 400°F
—HPC—	HIGH PRESSURE CONDENSATE
—LPS—	LOW PRESSURE STEAM – 20 PSIG
——→——	DIRECTION OF FLOW
(symbol)	CONDENSATE RECEIVER AND PUMP

DRAWING NOTES:

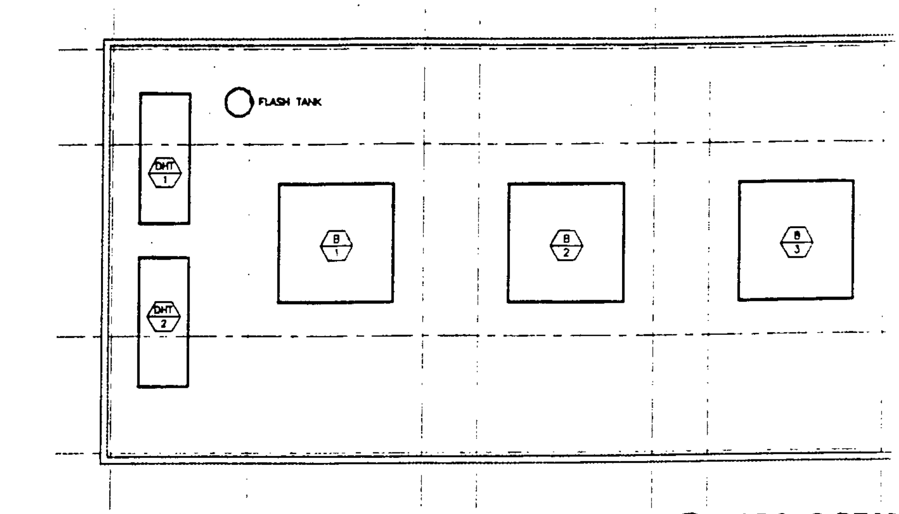
1. 100 PSIG STEAM SUPPLY PIPE REDUCED FROM 1-1/2" TO 3/4" TO FEED BUILDING HEATING.
2. HIGH PRESSURE CONDENSATE PIPE REDUCED FROM 8" TO 2".



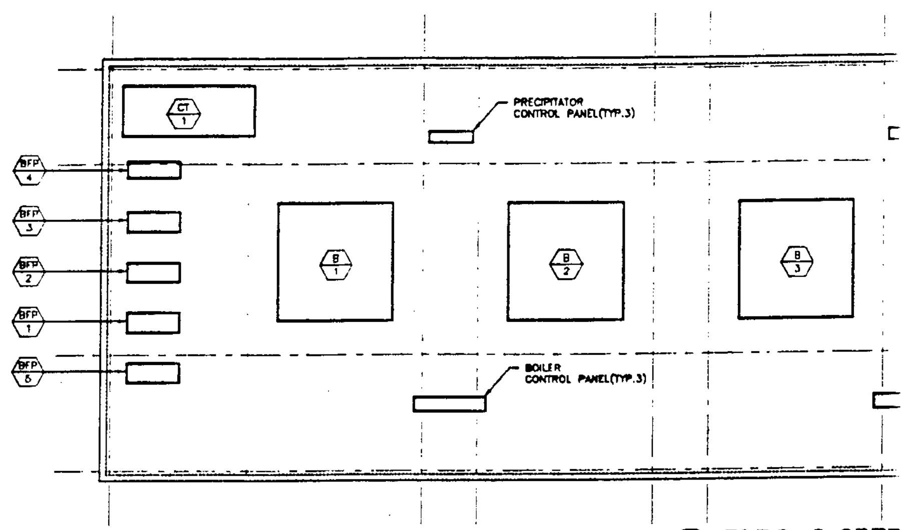
1 AREA 'A' STEAM & CONDENSATE DISTRIBUTION PIPING DIAGRAM
SCALE: NONE

NOTE:
THIS DWG. IS DIAGRAMMATIC IN NATURE AND DOES NOT SHOW EXPANSION LOOPS, STEAM TRAPS, ISOLATION VALVES, ACTUAL BUILDING SIZES, OR ACTUAL PIPE ROUTING.

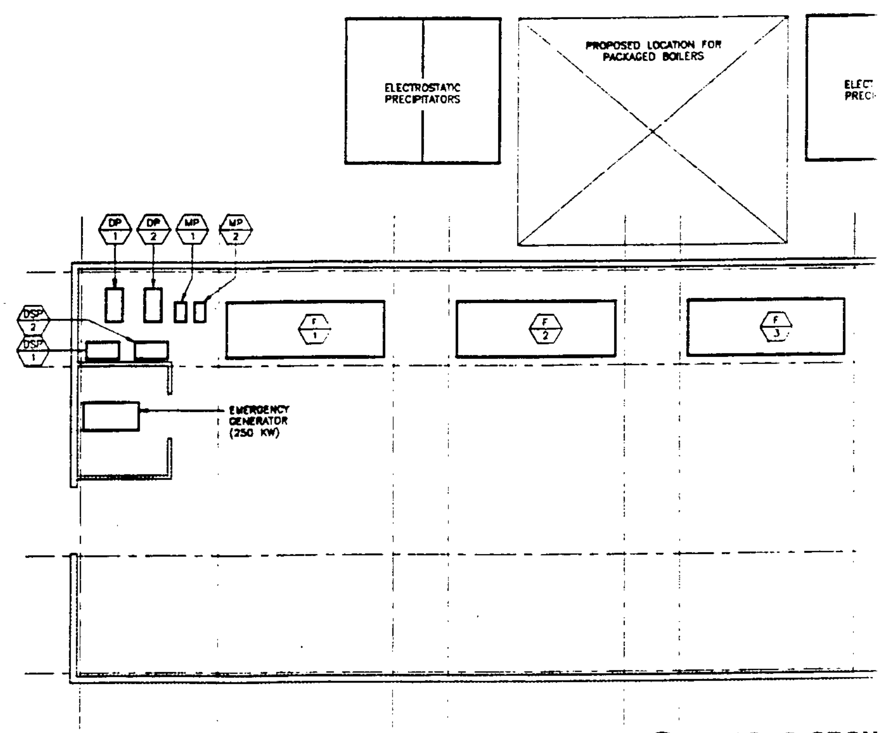
3



3 BLDG. 8 DEAI
SCALE: 1/16" = 1'-0"

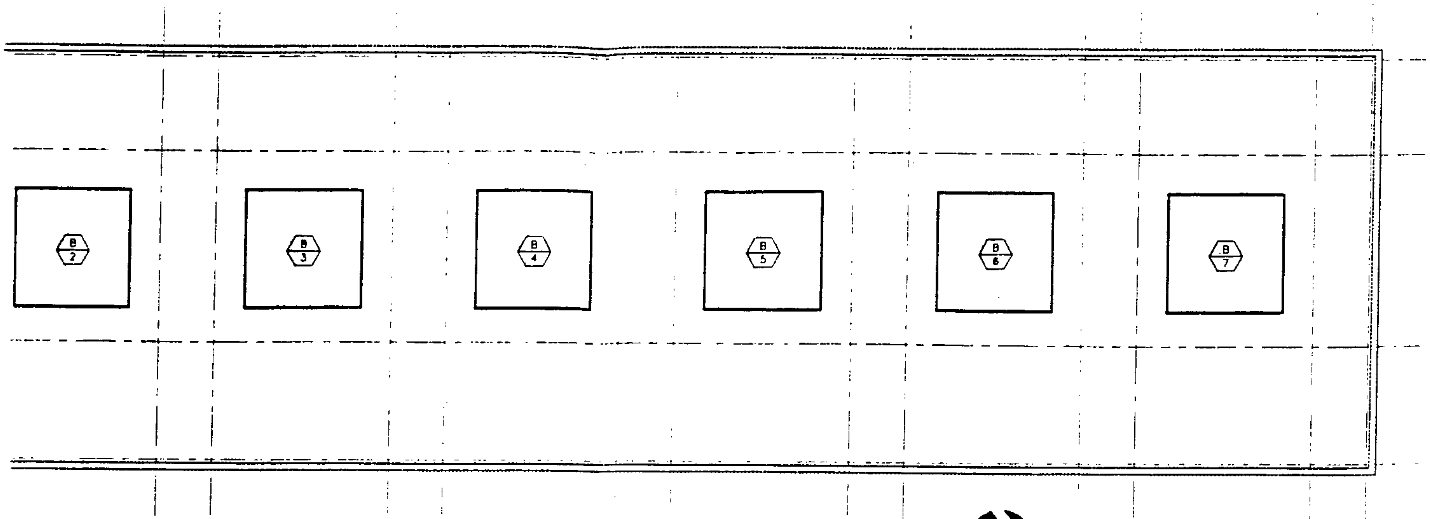


2 BLDG. 8 OPER
SCALE: 1/16" = 1'-0"

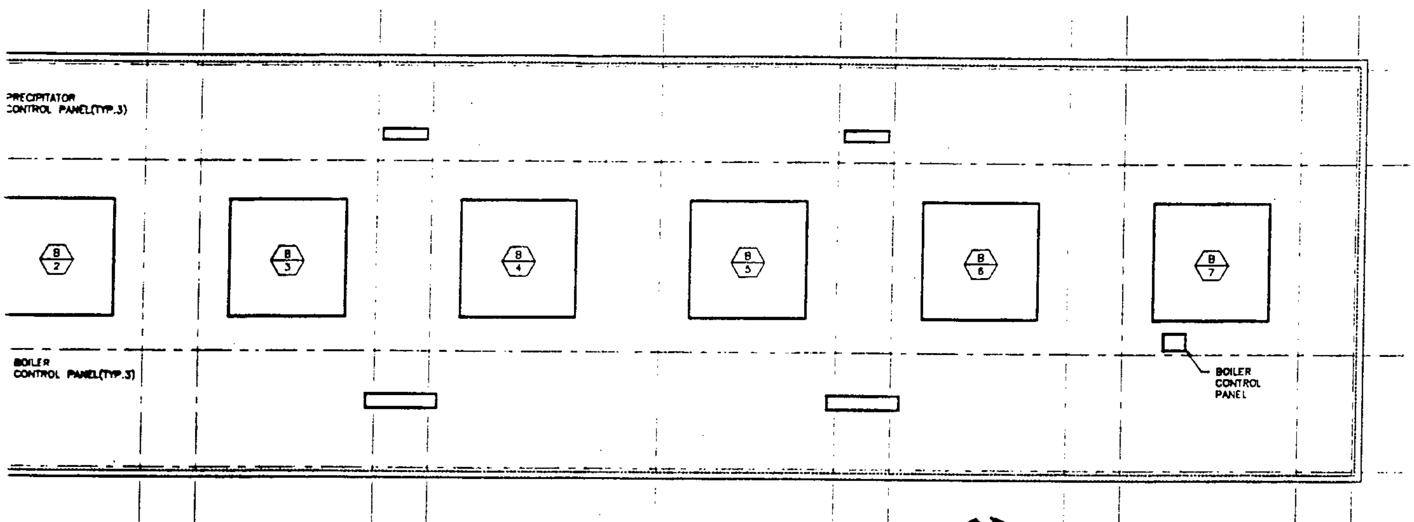


2 BLDG. 8 GROU
SCALE: 1/16" = 1'-0"

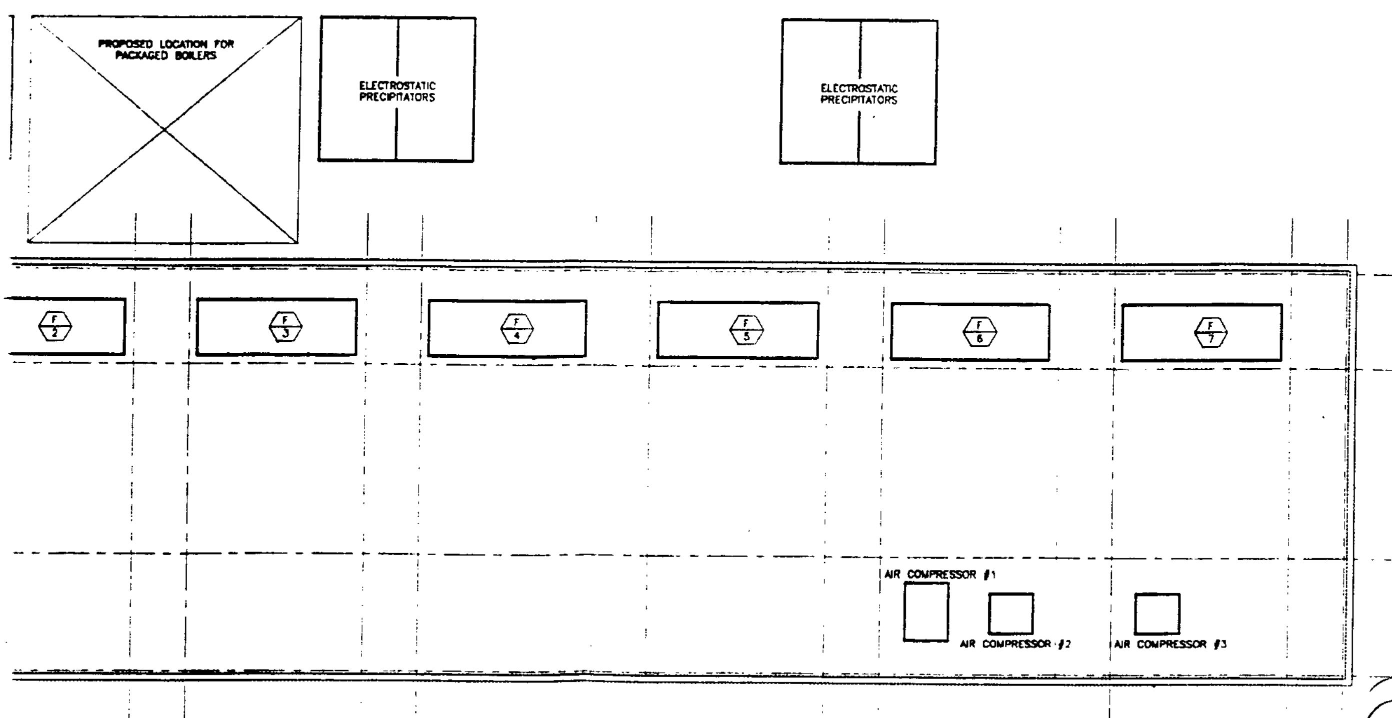
1



(3) **BLDG. 8 DEAERATOR HEATER FLOOR PLAN (EL. 1251'-3")**
SCALE: 1/16" = 1'-0"

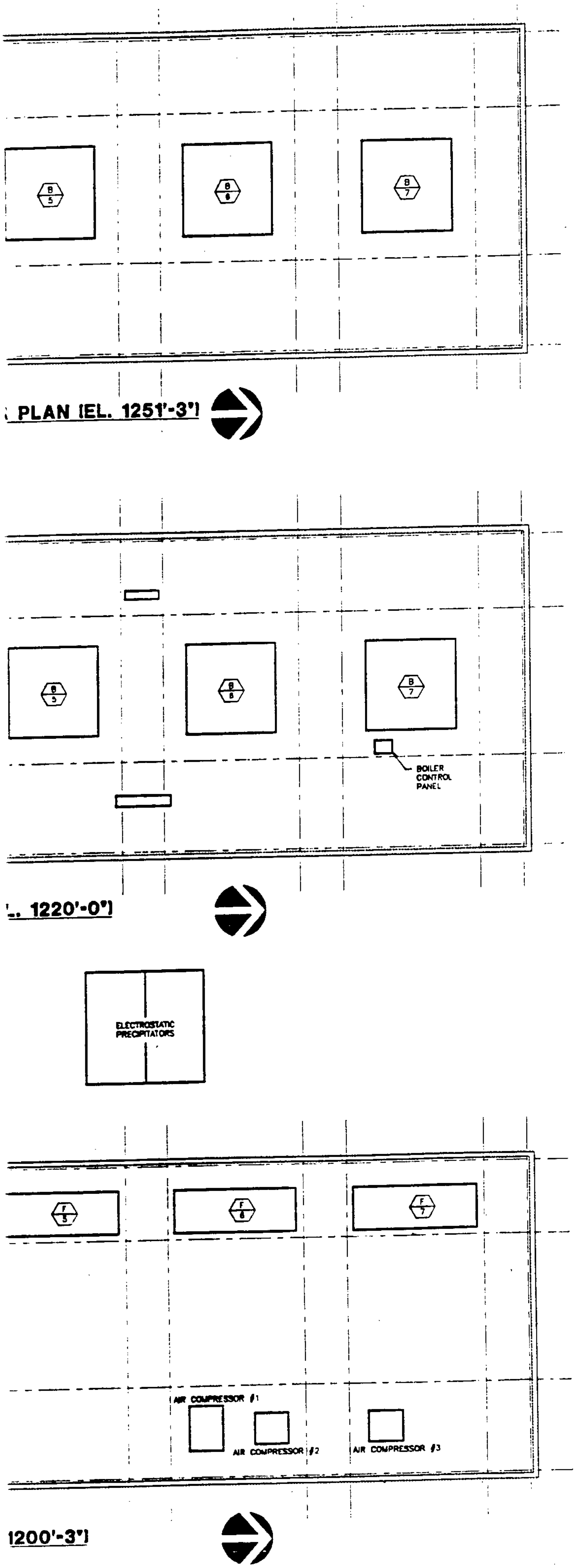


(2) **BLDG. 8 OPERATING FLOOR PLAN (EL. 1220'-0")**
SCALE: 1/16" = 1'-0"

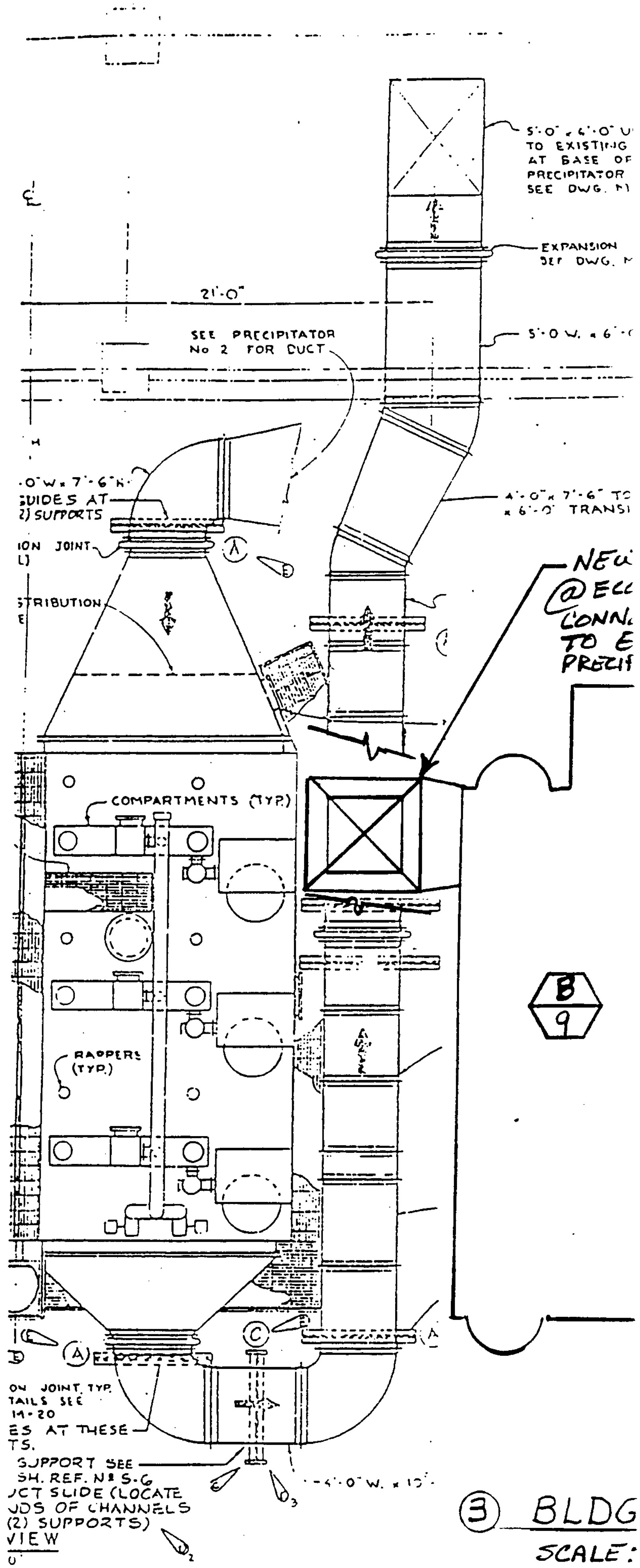


(2) **BLDG. 8 GROUND FLOOR PLAN (EL. 1200'-3")**
SCALE: 1/16" = 1'-0"

2


PLAN (EL. 1251'-3")
BOILER CONTROL PANEL
1220'-0")
ELECTROSTATIC PRECIPITATORS
AIR COMPRESSOR #1
AIR COMPRESSOR #2
AIR COMPRESSOR #3
1200'-3")

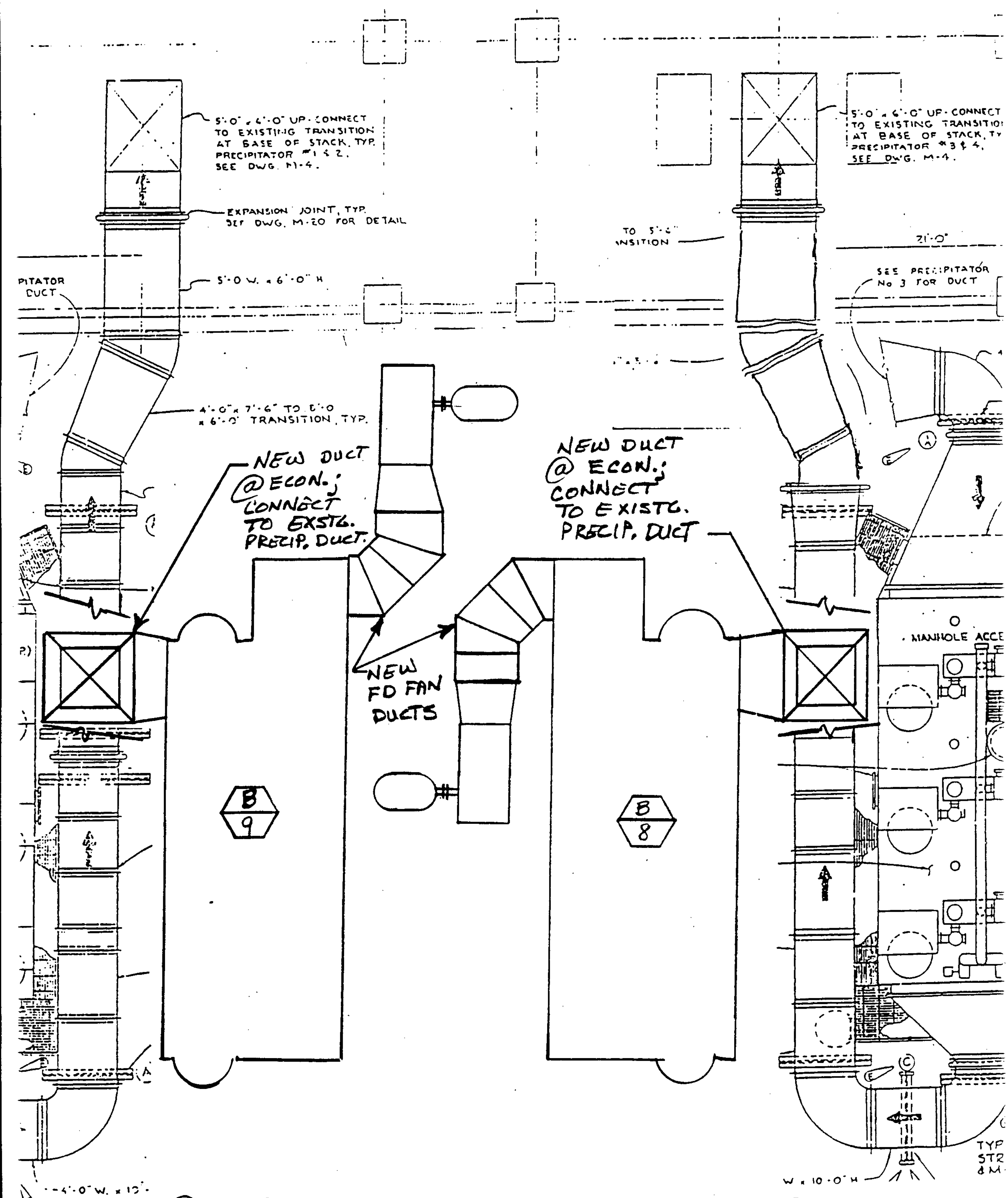
(3)



5'-0" x 6'-0" U
TO EXISTING
AT BASE OF
PRECIPITATOR
SEE DWG. N
EXPANSION
SEE DWG. N
21'-0"
SEE PRECIPITATOR
No 2 FOR DUCT
5'-0 W. x 6'-
.0"W x 7'-6"H
GUIDES AT
(2) SUPPORTS
ION JOINT
STRIBUTION
4'-0" x 7'-6" TO
x 6'-0" TRANSI
NEW
@ ECC
CONN.
TO E
PRECIP
COMPARTMENTS (TYP.)
RAPPERS
(TYP.)
B
9
ON JOINT, TYP.
TAILS SEE
14-20
ES AT THESE
TS.
SUPPORT SEE
SH. REF. No S-6
JCT SLIDE (LOCATE
JDS OF CHANNELS
(2) SUPPORTS)
VIEW
-4'-0" W. x 15'-
3 BLDG
SCALE:

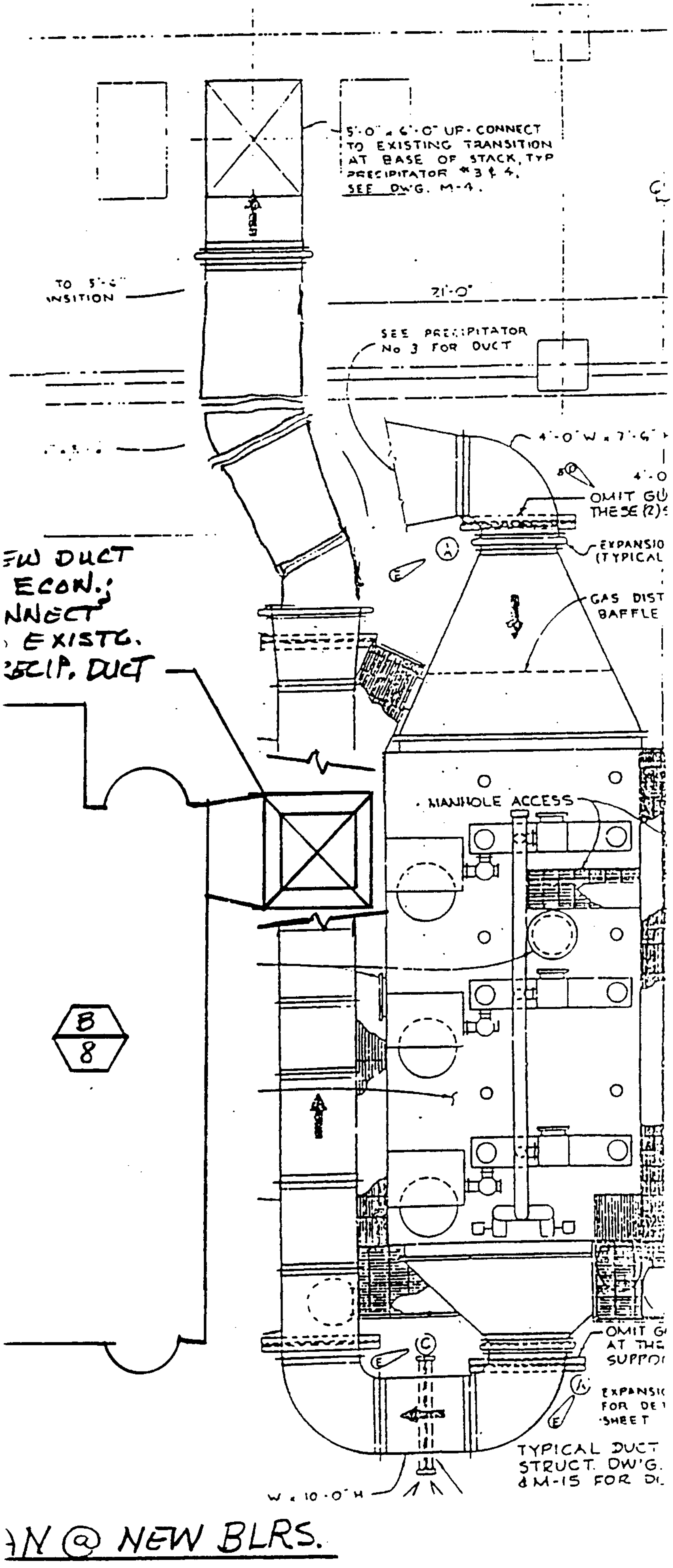
(1)

:5046-00



③ BLDG. 8 GR. FLR. PLAN @ NEW BLRS.

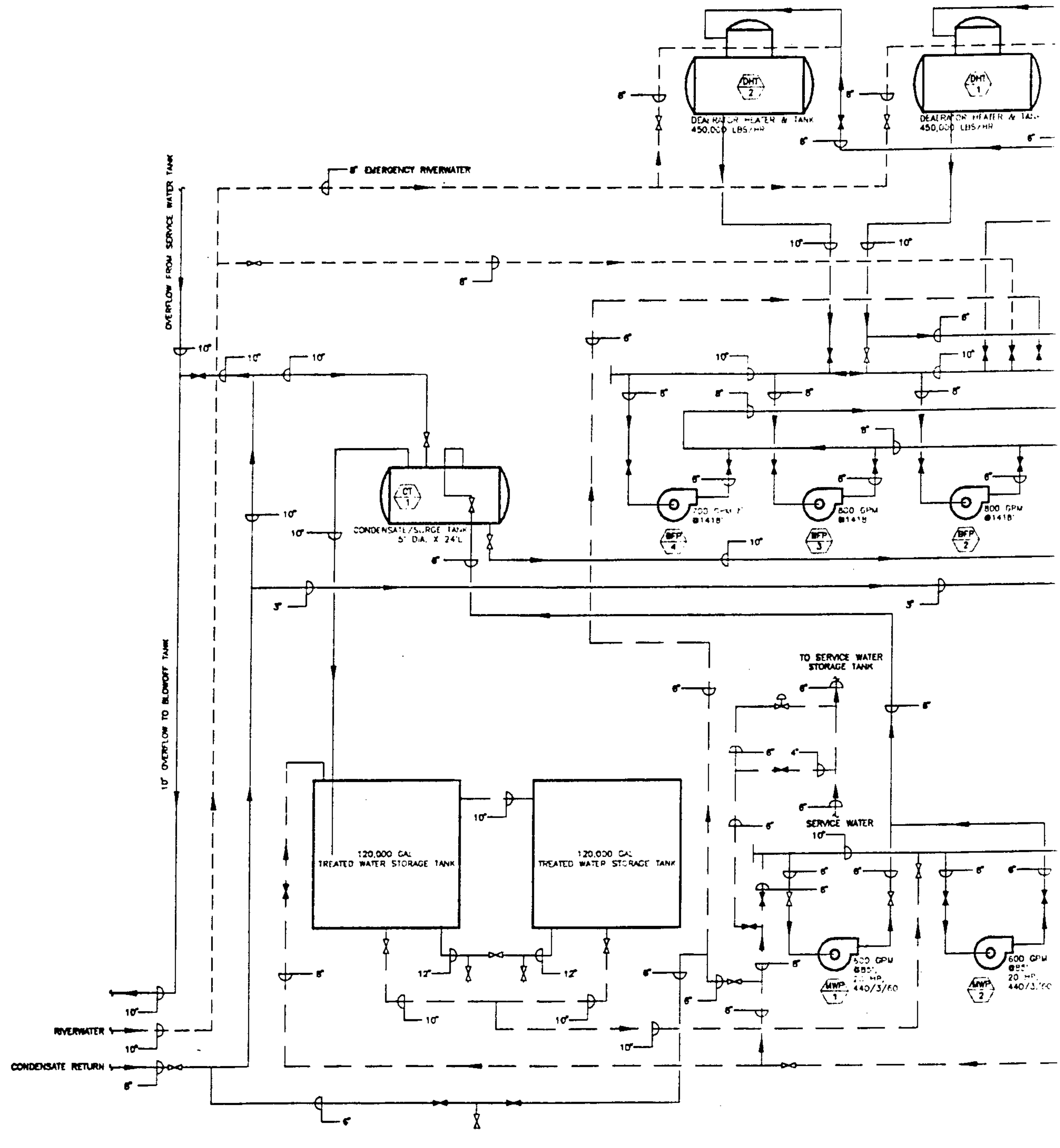
SCALE: 1/8" = 1'-0"



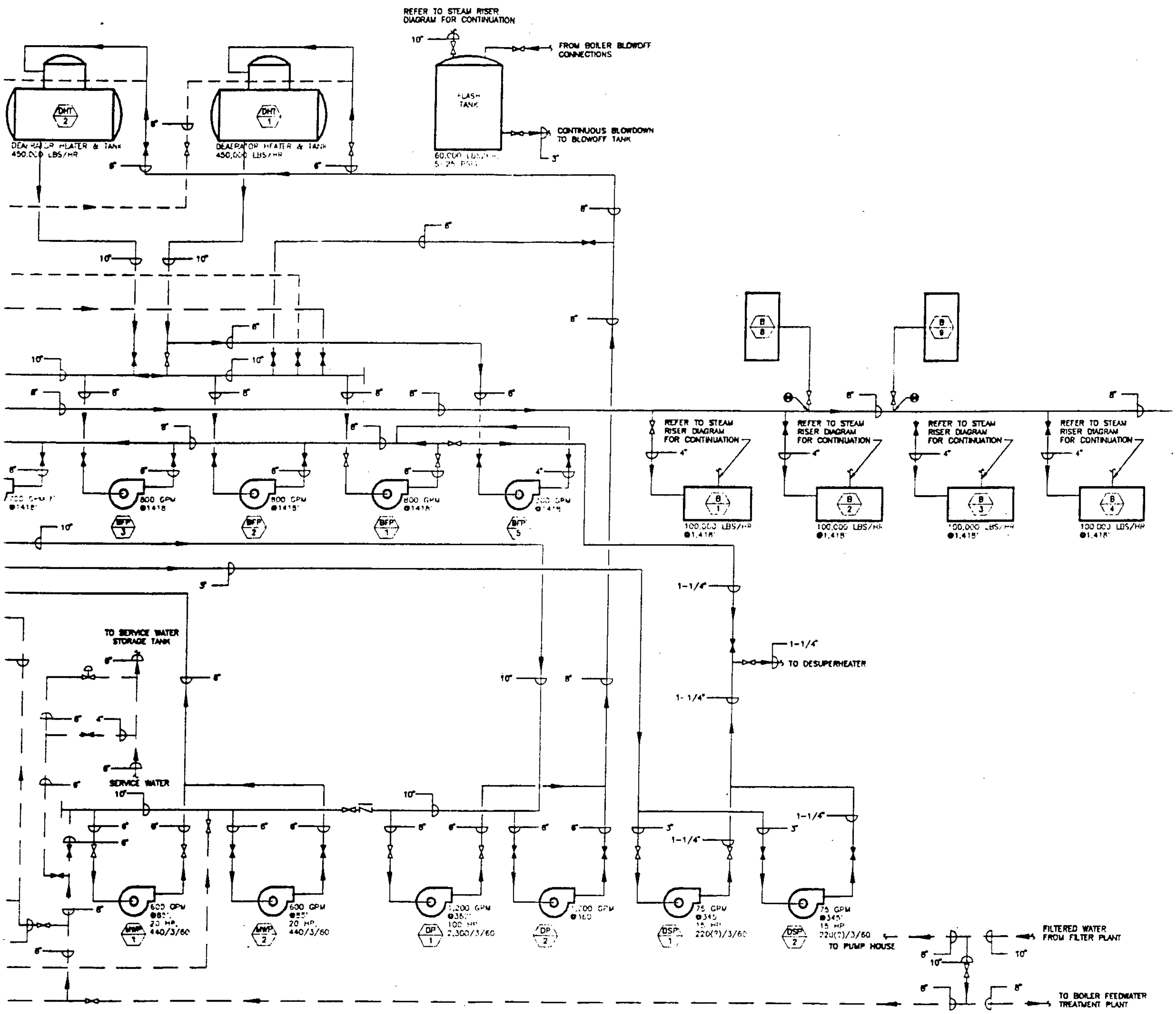
AN @ NEW BLRS.

LIMITED ENERGY STUDY
HOLSTON ARMY AMMUNITION
PLANT

(3)



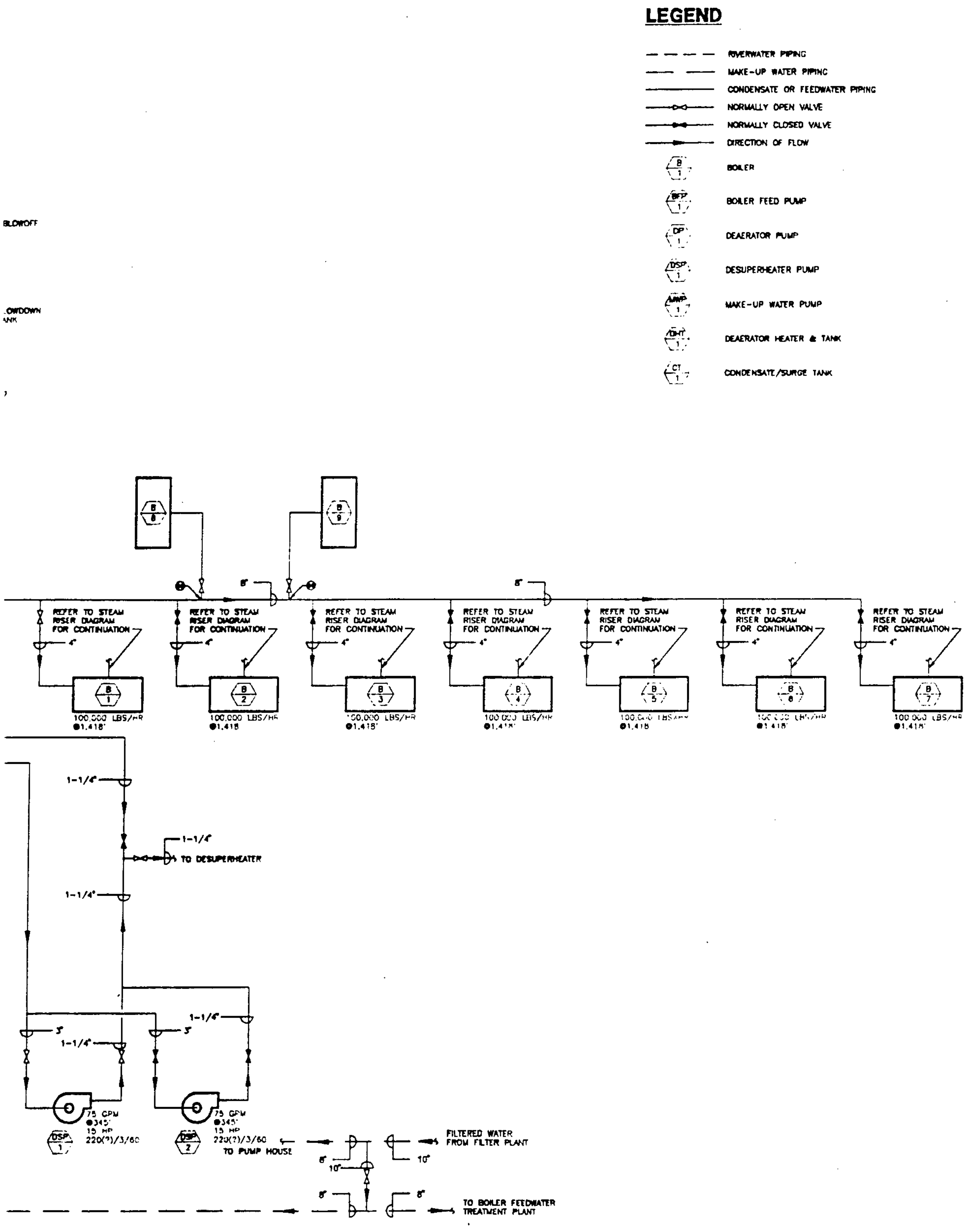
DEAERATOR HEATER & TANK
450,000 LBS/HR
DHT 2
DHT 1
8" EMERGENCY RIVERWATER
OVERFLOW FROM SERVICE WATER TANK
10" OVERFLOW TO BLOWOFF TANK
CONDENSATE/SURGE TANK
5' DIA. X 24'L
CT 1
700 GPM
800 GPM
BFP 4
BFP 3
BFP 2
TO SERVICE WATER STORAGE TANK
SERVICE WATER
120,000 GAL TREATED WATER STORAGE TANK
120,000 GAL TREATED WATER STORAGE TANK
600 GPM
20 HP
440/3/60
MWP 1
MWP 2
RIVERWATER
CONDENSATE RETURN



4 BLDG. 8 CONDENSATE & FEEDWATER RISER DIAGRAM

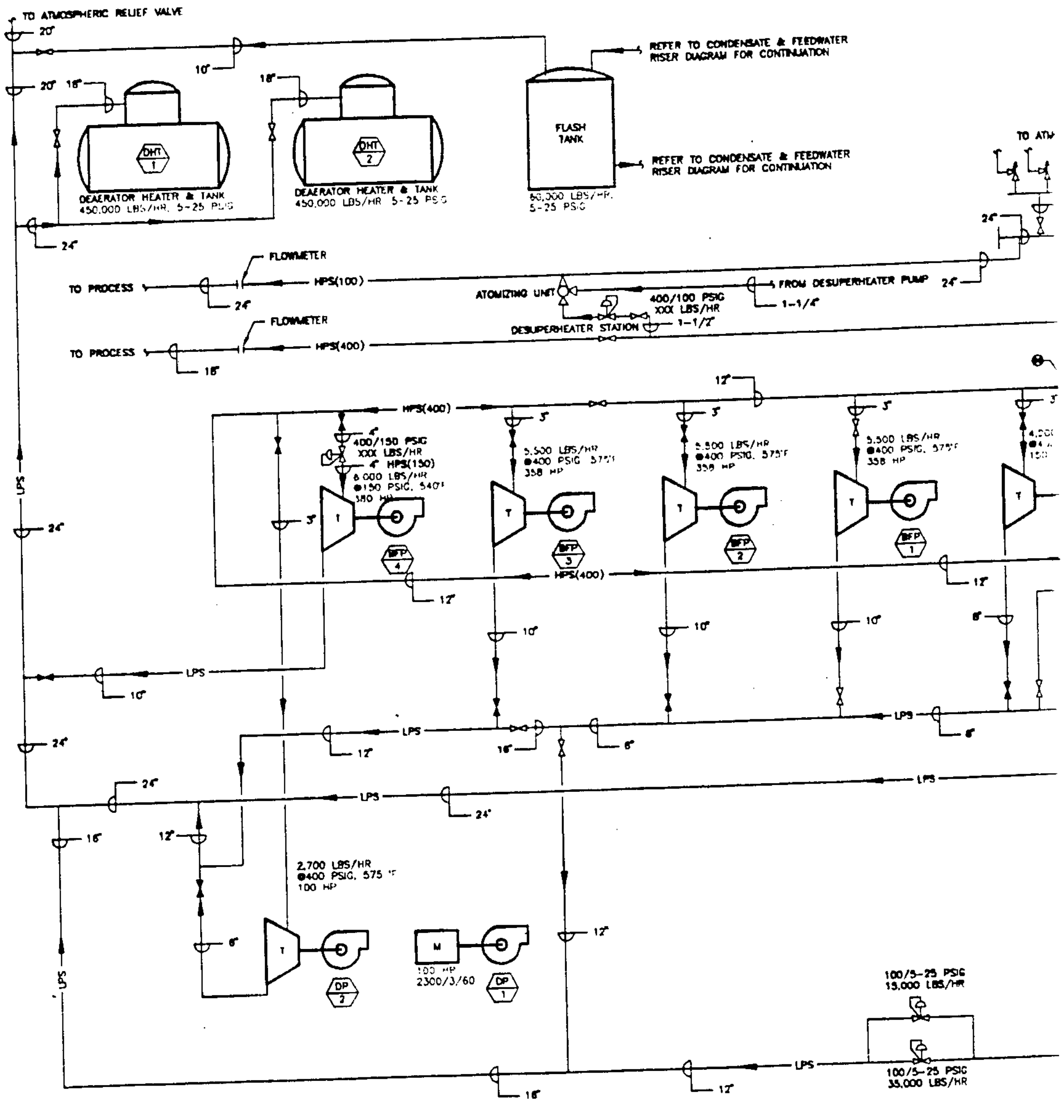
SCALE: NONE

2



)WATER RISER DIAGRAM

(3)



TO ATMOSPHERIC RELIEF VALVE
REFER TO CONDENSATE & FEEDWATER RISER DIAGRAM FOR CONTINUATION
FLASH TANK
DEAERATOR HEATER & TANK 450,000 LBS/HR, 5-25 PSIG
FLOWMETER
TO PROCESS
HPS(100)
HPS(400)
ATOMIZING UNIT
400/100 PSIG XXX LBS/HR
DESUPERHEATER STATION
FROM DESUPERHEATER PUMP
400/150 PSIG XXX LBS/HR
5,500 LBS/HR @400 PSIG, 575°F 358 HP
LPS
2,700 LBS/HR @400 PSIG, 575 °F 100 HP
100 HP 2300/3/60
100/5-25 PSIG 15,000 LBS/HR
100/5-25 PSIG 35,000 LBS/HR

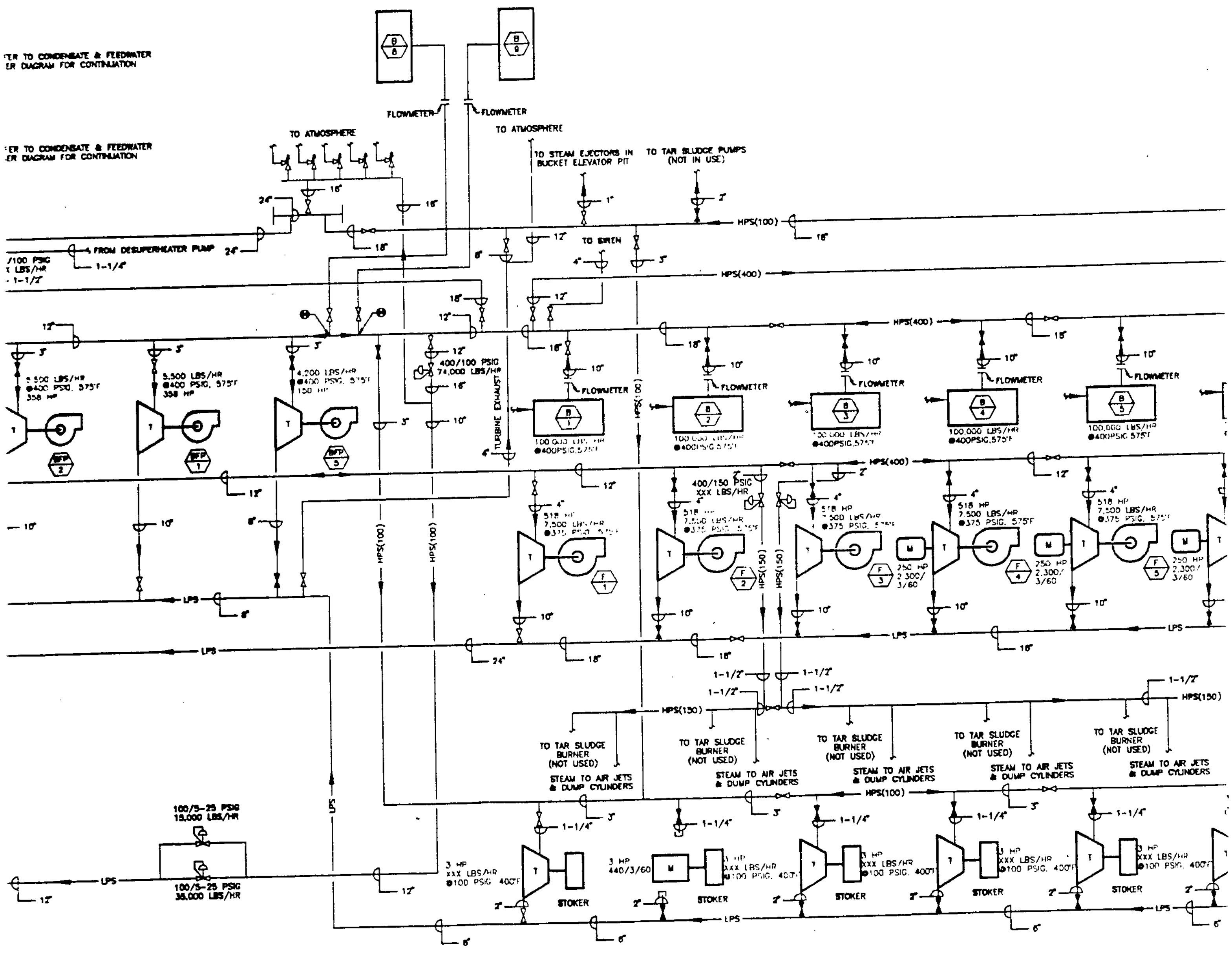
1

LEGEND

—HPS(400)—	HIGH PRESSURE STEAM - 400 PSIG, 575°F
—HPS(150)—	HIGH PRESSURE STEAM - 150 PSIG, 540°F
—HPS(120)—	HIGH PRESSURE STEAM - 100 PSIG, 400°F
—HPC—	HIGH PRESSURE CONDENSATE
—LPS—	LOW PRESSURE STEAM - 5-25 PSIG
	DIRECTION OF FLOW
	PUMP OR FAN
	NORMALLY OPEN VALVE
	NORMALLY CLOSED VALVE

ANCILLARY EQUIPMENT:

COAL CRUSHER-	50 HP, 440/3/60
APRON FEEDER-	5 HP, 440/3/60
BUCKET ELEVATOR-	25 HP, 440/3/60
ACID PUMPS-	10 HP, 440/3/60
BRINE PUMPS-	2@?, 440/3/60
CHEMICAL FEED PUMPS-	3@1/4 HP, 440/3/60
CHEMICAL FEED PUMPS-	2 UNITS, 2 PUMPS/UNIT, 3 HP, 440/3/60



5 BLDG. 8 STEAM RISER DIAGRAM

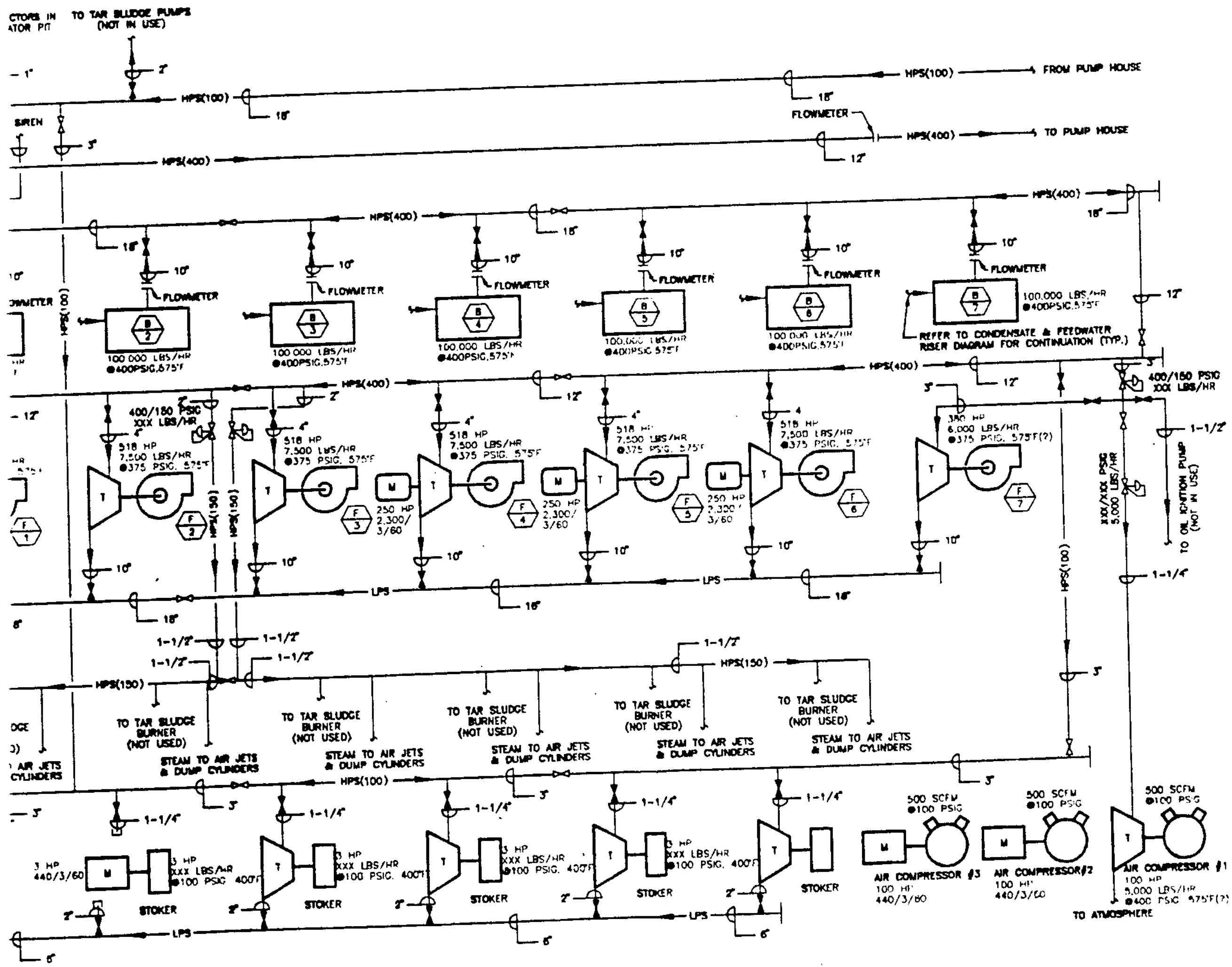
SCALE: NONE

2

ARY EQUIPMENT:	
CRUSHER-	50 HP, 440/3/60
FEEDER-	5 HP, 440/3/60
T ELEVATOR-	25 HP, 440/3/60
PUMPS-	10 HP, 440/3/60
PUMPS-	2@7, 440/3/60
CAL FEED PUMPS-	3@1/4 HP, 440/3/60
CAL FEED PUMPS-	2 UNITS, 2 PUMPS/UNIT, 3 HP, 440/3/60

LEGEND

—HPS(400)—	HIGH PRESSURE STEAM - 400 PSIG, 575°F
—HPS(150)—	HIGH PRESSURE STEAM - 150 PSIG, 540°F
—HPS(120)—	HIGH PRESSURE STEAM - 100 PSIG, 400°F
—HPC—	HIGH PRESSURE CONDENSATE
—LPS—	LOW PRESSURE STEAM - 5-25 PSIG
	DIRECTION OF FLOW
	PUMP OR FAN
	NORMALLY OPEN VALVE
	NORMALLY CLOSED VALVE



EAM RISER DIAGRAM

3

FY95 LIMITED ENERGY STUDY
HOLSTON ARMY AMMUNITION PLANT
95046-00

Appendix 5 - Telephone Conversations

Telephone Conversation

AEI
Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, FL 32608

Conversation With: WAYNE CERNY	Routing:
Representing: INDECK	Project Number: 95046-00
Project Name: HOLSTON	Date: 10-24-95
Location:	Time:

WILL HAVE PRICING TO US NO LATER THAN FRIDAY -

THEY HAVE A CLE. BR. INDUSTRIAL D-42 ON HAND (RETURN FROM OTHER RENTAL) WHICH HE WILL QUOTE

WILL ALSO QUOTE ON A FIRETUBE LIKE YORK-SHIPLEY.

By:

Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, FL 32608

Telephone Conversation

Conversation With: ~~[illegible]~~ MIKE RAMSEY

Routing:

Representing: ABCO INDUSTRIES

Project Number: 95046-00

Project Name: HOLSTON BOILER

Date: 10-24-95

Location:

Time:

WILL REVIEW WHAT THEY HAVE AVAILABLE AND CALL BACK.

By:

Telephone Conversation

Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, FL 32608

Conversation With: ROLAND

Representing: CENTRAL TEXAS AIR

Project Name: HOLSTON BOILER STUDY

Location:

Routing:

Project Number: 95046-00

Date: 10-24-95

Time:

CAN HAVE QUOTATION BY FRI. PM FOR SYSTEM INCL. 750T FIRE TUBE (I.E. CLEAVER-BROOKS) FOR SEMI-PERMANENT INSTAL. INSIDE A GOV'T BLDG. & W/ SEP. PRICE FOR D.A. SKID.

By:

CLASSIFIEDS

Fax Randy Green your Classified at (810)362-0317 or call (810)837-7370/ext.3 for more info.

Kennedy Tank & Mfg Co Inc
Nationwide Boilers Inc
Riley Stoker Corp

BOILER SERVICE, RENTAL
ABCO Industries Inc
Clayton Industries
Indeck Power Equipment Co
Nationwide Boilers Inc

BOILER SERVICE, RETUBING
ABCO Industries Inc
Advance Boiler & Tank Co
Babcock & Wilcox
The Bigelow Co
General Electric Company,
  Business Info Center
Goltens
Indeck Power Equipment Co
Kennedy Tank & Mfg Co Inc
Nationwide Boilers Inc
Riley Stoker Corp
Turnbull & Sons Ltd

BOILER SERVICE, OTHER
ABCO Industries Inc
Cooperheat Inc, Heat Tracing Dept
General Electric Company,
  Business Info Center
Helmick Corp
Nationwide Boilers Inc
Pilbrico Company

BOILER WATER TREATMENT, CHEMICAL SYSTEM
Alken-Murray Corp
Applikon
Aqua-Tech Inc
Betz Industrial, Water Mgt Div Of Betz Labs
Burman Technical Serv Inc,
  Water Management Div
Calgon Corp, Commercial Div
Cambridge Scientific Ind
Capital Controls Co Inc
Certified Laboratories, Eastern Div
Chargar Corp, Elgene Div
Chemed Corporation, Dubois Chemicals
Chemical Testing Corp
Clark-Cooper Corp
Clayton Industries
Dearborn Div, W. R. Grace & Co.
Dexter Corp, Mogul Div
...s Inc
...EW/ASHLAND, Drew Industrial Div
  (See Catalog Pages J-25—J-28)
The Duriron Co Inc, Filtration Systems Div
THE FOXBORO COMPANY
  (See Ad Pages K-8, K-9)
Garratt-Callahan Co
GELBER PUMPS INC
  (See Ad Page 150)
Herman Bogot & Co
Hydroflo Corp
Illinois Water Treatment Co
Indeck Power Equipment Co
Jamestown Chemical Co Inc
Lancy International Inc
Mitco Inc
Monarch Water Systems, A Div Systech Corp
Nalco Chemical Co
Nationwide Boilers Inc
Neptune Chemical Pump Co
Olin Corp, Olin Water Svcs
PSE International Inc
Resources Conservation Co
Signet Scientific Co Div
TVC Inc, TVC Systemms
Watcon Inc

BOILER WATER TREATMENT, CHEMICALS
Alken-Murray Corp
Aqua-Tech Inc
Atomergic Chemetals Corp
Betz Industrial, Water Mgt Div Of Betz Labs
Bowman Distribution, Barnes Group Inc
Burman Technical Serv Inc,
  Water Management Div
Calgon Corp, Commercial Div
Certified Laboratories, Eastern Div
Chargar Corp, Elgene Div
Chemed Corporation, Dubois Chemicals
Chemical Testing Corp
Clayton Industries
Dearborn Div, W. R. Grace & Co.
...ter Corp, Mogul Div
...s Inc
...EW/ASHLAND, Drew Industrial Div
  (See Catalog Pages J-25—J-28)
Dustbane Products Company
Garratt-Callahan Co
Jamestown Chemical Co Inc
J C Whitlam Mfg Co
Mitco Inc
Nalco Chemical Co
Nationwide Boilers Inc
Oakite Products Inc
Olin Corp, Olin Water Svcs
Western Chemical Co
Wright Chemical Corp

BOILER WATER TREATMENT, NON-CHEMICAL SYSTEM
Aqua Dynamics Corp
Aqua-Tech Inc
Cambridge Scientific Ind
C I Inc
Clayton Industries
Cleaver-Brooks
Culligan Intl
CX/Oxytech
The Duriron Co Inc, Filtration Systems Div
Environmental Elements Corp
Graver Co, Graver Water Div
Great Lakes Filter
Hydro Max Corp,
  Member Raytec Water Group
Kemtune Inc, Superior Water Conditioners
Mitco Inc
Monarch Water Systems, A Div Systech Corp
Nationwide Boilers Inc
Osmo Membrane Sys Div, Osmonics Inc
Pall Process Filtration Corp, Div Pall Corp
Permutit Co Inc
Progressive Equipment Corp
Resources Conservation Co
Saltech Corp
Scale Control Sys
Water Refining Co Inc, Industrial Div

BOILER, BY APPLICATION, COGENERATION
ABCO Industries Inc
Babcock & Wilcox
The Bigelow Co
Cain Industries
C-E Power Systems,
  Combustion Engineering Inc
Clayton Industries
Energy Systems, Div Midwesco Inc
Federal Boiler Company
Henry Vogt Machine Co
Herman Bogot & Co
Indeck Power Equipment Co
The Intl Boiler Works Co
John Zink Co, Allegheny International
Mitsubishi Heavy Indus Americ
Montgomery Brothers Inc
Olin Corp, Olin Water Svcs
Riley Stoker Corp
Solar Turbines Inc, Subs Caterpillar Tractor Co
Struthers Wells Corp
Systech Corporation
TVC Inc, TVC Systemms
United States Filter, Fluid Systems Corp
Vapor Corp, Div of Brunswick

BOILER, BY APPLICATION, HOT WATER
ABCO Industries Inc
The Bigelow Co
Brasch Mfg Co Inc
Bryan Steam Corp
Burnham Corp, Hydronics Div
CAM Industries Inc
Carrier Air Conditioning, Carrier Corp
C-E Power Systems,
  Combustion Engineering Inc
CHROMALOX-E L WIEGAND DIV,
  Emerson Electric Co
  (See Catalog C/CHR)
Clayton Industries
Cleaver-Brooks
Columbia Boiler Co Pottstown
Edwards Engineering Corp
Federal Boiler Company
Fluidyne Engr Corp
Fulton Boiler Works Inc
Herman Bogot & Co
Hydrotherm
Indeck Power Equipment Co
Industrial Boiler Co Inc
The Intl Boiler Works Co
Mitsubishi Heavy Indus Americ
Montgomery Brothers Inc
Nationwide Boilers Inc
Olin Corp, Olin Water Svcs
Ray Burner Company
Raypak Inc
Reimers Electra Steam Inc
Scale Control Sys
Slant Fin Corporation
Systech Corporation
Vapor Corp, Div of Brunswick
Weil-McLain, A Marley Co

BOILER, BY APPLICATION, STEAM
ABCO Industries Inc
Babcock & Wilcox
The Bigelow Co
Brasch Mfg Co Inc
Bryan Steam Corp
Burnham Corp, Hydronics Div
CAM Industries Inc
Carrier Air Conditioning, Carrier Corp
C-E Power Systems,
  Combustion Engineering Inc
CHROMALOX-E L WIEGAND DIV,
  Emerson Electric Co
  (See Catalog C/CHR)
Clayton Industries
Cleaver-Brooks
Columbia Boiler Co Pottstown
Electric Steam Generator Corp
Electro-Steam Generator Corp
Energy Systems, Div Midwesco Inc
Federal Boiler Company
Fluidyne Engr Corp
Fulton Boiler Works Inc
Henry Vogt Machine Co
Herman Bogot & Co
Hydrotherm
Indeck Power Equipment Co
Industrial Boiler Co Inc
The Intl Boiler Works Co
Keeler/Dorr-Oliver
Mitsubishi Heavy Indus Americ
Montgomery Brothers Inc
Nationwide Boilers Inc
Olin Corp, Olin Water Svcs
Ray Burner Company
Reimers Electra Steam Inc
Riley Stoker Corp
Scale Control Sys
Slant Fin Corporation
Systech Corporation
Vapor Corp, Div of Brunswick
Weil-McLain, A Marley Co

BOILER, BY APPLICATION, OTHER
ABCO Industries Inc
Cain Industries
Federal Boiler Company
Fulton Boiler Works Inc
Hydrotherm
The Intl Boiler Works Co
Systech Corporation

BOILER, BY TYPE, ELECTRIC OR ELECTRODE
Automatic Steam Prods Corp
Brasch Mfg Co Inc
Bryan Steam Corp
CAM Industries Inc
CHROMALOX-E L WIEGAND DIV,
  Emerson Electric Co
  (See Catalog C/CHR)
Edwards Engineering Corp
Electric Steam Generator Corp
Fulton Boiler Works Inc
Herman Bogot & Co
Hynes Electric Heating Co
Indeck Power Equipment Co
INDEECO
  (See Ad Page C-45)
The Intl Boiler Works Co
Montgomery Brothers Inc
Olin Corp, Olin Water Svcs
Patterson-Kelley Co, Div Harsco Corp
Reimers Electra Steam Inc
Scale Control Sys
Slant Fin Corporation

BOILER, BY TYPE, FIRETUBE
ABCO Industries Inc
Babcock & Wilcox
Basic Environmental Eng Inc
The Bigelow Co
Burnham Corp, Hydronics Div
Cleaver-Brooks
Columbia Boiler Co Pottstown
Energy Controls Inc
Federal Boiler Company
Herman Bogot & Co
Indeck Power Equipment Co
Industrial Boiler Co Inc
Industrial Combustion, Div of Aqua-Chem
John Zink Co, Allegheny International
Nationwide Boilers Inc
Olin Corp, Olin Water Svcs
Ray Burner Company
Scale Control Sys
Struthers Wells Corp
Systech Corporation
Thermal Transfer Corp
Wabash Power Equipment Co

BOILER, BY TYPE, FLUIDIZED BED
ABCO Industries Inc
Babcock & Wilcox
The Bigelow Co
C-E Power Systems,
  Combustion Engineering Inc
Fluidyne Engr Corp
The Intl Boiler Works Co
Keeler/Dorr-Oliver
Riley Stoker Corp
Struthers Wells Corp

BOILER, BY TYPE, WASTE HEAT
ABCO Industries Inc
Babcock & Wilcox
Basic Environmental Eng Inc
The Bigelow Co
Cain Industries
C-E Power Systems,
  Combustion Engineering Inc
Cleaver-Brooks
Electro-Steam Generator Corp
Epcon Industrial Systems Inc
Federal Boiler Company
Henry Vogt Machine Co
Herman Bogot & Co
Indeck Power Equipment Co
Industrial Boiler Co Inc
The Intl Boiler Works Co
John Zink Co, Allegheny International
Mitsubishi Heavy Indus Americ
Olin Corp, Olin Water Svcs
Parker Boiler Co
RILEY-BEAIRD INC
  (See Ad Page J-11)
Riley Stoker Corp
Simonds Manufacturing Corp
Solar Turbines Inc, Subs Caterpillar Tractor Co
Struthers Wells Corp
Thermal Transfer Corp
Vapor Corp, Div of Brunswick

BOILER, BY TYPE, WATERTUBE
ABCO Industries Inc
Babcock & Wilcox
Basic Environmental Eng Inc
The Bigelow Co
Bryan Steam Corp
C-E Power Systems,
  Combustion Engineering Inc
Clayton Industries
Cleaver-Brooks
Columbia Boiler Co Pottstown
Henry Vogt Machine Co
Herman Bogot & Co
Indeck Power Equipment Co
The Intl Boiler Works Co
John Zink Co, Allegheny International
Keeler/Dorr-Oliver
Mitsubishi Heavy Indus Americ
Nationwide Boilers Inc
Olin Corp, Olin Water Svcs
Raypak Inc
Riley Stoker Corp
Thermal Transfer Corp
Vapor Corp, Div of Brunswick
Wabash Power Equipment Co

BOILER, BY TYPE, OTHER
ABCO Industries Inc
Cleaver-Brooks
Fulton Boiler Works Inc
The Intl Boiler Works Co
Slant Fin Corporation
Systech Corporation
Weil-McLain, A Marley Co

BOLT (SEE "FASTENER")

BOOK (SEE "PUBLICATION, TECHNICAL REFERENCE)

BOOTH, PAINT SPRAYING
Alemite Div, Stewart-Warner Corp
Binks Manufacturing Co
Cambridge Engineering Inc
Chemco Mfg Co Inc
Columbus Industries Inc
Cutler
G&C Automation Projects Inc
GEORGE KOCH SONS INC
  (See Ad Page 140)
Nycoil Company
Paasche Airbrush Co
Protectaire Systems Co
Tri-Dim Filter Corp
Westfield Sheet Metal Works

BOOTH, SECURITY
A Liss & Co Inc
C&H Distributors Inc
Easi-Set Industries
Global Equipment Co

Telephone Conversation

Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, FL 32608
(904)376-5500 [FAX 375-3479]

Holston AAP Boiler Study	95046-00
Project	Project #
Martin Drinkard	September 18, 1995
Conversation With	Date
Norfolk Southern Railroad	1 of ?
Representing	Page / Typist
August 23, 1995	PDL
Date & Time of Conversation	Copies / File

RE: Movement of Boiler from Volumteer AAP to Holston AAP

Per Mr. Drinkard, Norfolk Southern is capable of moving the boilers from the Volunteer AAP outside of Chattanooga, TN, to Holston AAP outside of Kingsport, TN. However, there are a couple of areas of difficulty which will have to be worked out if it is decided to move the boilers, as follows:

1. Norfolk Southern will only transport the boilers and provide recommendations for proper rigging at time of loading. All handling of the boilers at each end will have to be by others.

2. There is some concern about the use of the sidings at each end of the trip. While Norfolk Southern has the rights to the tracks in Chattanooga, CSX has the rights to the local sidings in the Kingsport area. NOTE: it might be possible to set up a shipment through intermodal (multiple carriers). This might affect the rate slightly.

3. The base rate for transportation is $3.72 per hundredweight. This results in a transportation cost of $5208 per boiler or $10,416 for both. There is no discount for multiple units.

4. If it is decided to ship the boilers, enough notice will have to be provided to arrange for detailed routing and scheduling. NOTE: "Enough notice" was not defined during our conversation.

Raymond F. Parham, P.E.
Plumbing/Fire Protection Project Engineer

Telephone Conversation

AEI
Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, FL 32608

JIM FRY (615-855-7109)	CO, PDL
Conversation With	Routing
VOLUNTEER AAP, CHATTANOOGA, TN	95046-00
Representing	Project Number
HOLSTON AAP BOILER STUDY	7/11/95
Project Name	Date
HOLSTON, TN	10:15 AM
Location	Time

I REQUESTED MR. FRY'S FAX NUMBER SO WE COULD SEND THE BOILER INSPECTION AGENDA, EQUIPMENT LIST, AND REQUEST FOR BOILER DOCUMENTATION TO HIM. FAX. NO. 615-855-7205

I INFORMED MR FRY OF OUR INTENDED INSPECTION SURVEY FROM JULY 24 THROUGH JULY 28, 1995 BY THE BOILER INSPECTOR AND ABSE'S INSPECTION FROM JULY 25 THROUGH JULY 27, 1995.

I ALSO INFORMED MR. FRY THAT THE BOILER INSPECTOR WOULD LIKE TO PERFORM A PRELIMINARY SURVEY ON JULY 19, 1995 AND WOULD REQUIRE A CAMERA PASS.

I ASKED FOR DIRECTIONS TO THE VOLUNTEER PLANT (ATTACHED). THE PLANT IS LOCATED ON THE NORTHEAST SIDE OF CHATTANOOGA. LODGING IS AVAILABLE AT THE I-75/SHALLOWFORD RD. EXIT AND THE I-75/BONNIE OAKS DR. EXIT.

CONTACT MR. PAUL HOLLIS (855-7111) AS ALTERNATE POINT OF CONTACT IF MR. FRY UNAVAILABLE.

By: ROBERT A. BARNES, P.E.
HVAC PROJECT ENGINEER

DIRECTIONS TO VOLUNTEER AAP

COMING FROM ATLANTA ON I-75 GOING TOWARDS KNOXVILLE, PASS SHALLOWFORD RD. EXIT (LARGE MALL IN VICINITY), GET OFF AT BONNIE OAKS DR (HWY 215(?) OR 315(?)), GO UNDERNEATH OVERPASS. CONTINUE TO 4-WAY STOP, GO THROUGH 4-WAY STOP TO NEXT RED LIGHT (APPROX 1-1½ MI.), WHICH SHOULD BE ENTRANCE TO PLANT.

Telephone Conversation

AEI
Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, FL 32608

Conversation With: SCOTT SHELTON
Representing: HDC
Project Name: HOLSTON BLR/ACID STUDY
Location:

Routing:
Project Number: 95046-00
Date: 8-31-95
Time: 4:00

SCOTT JUST GOT OUT OF A MEETING AND FOUND THE INFO THAT JERRY B. HAD COLLECTED ON HIS DESK (JUST ARRIVED). HE SAYS THEIR FAX OFFICE IS ALLREADY CLOSED TODAY, AND SINCE MONDAY IS A HOLIDAY, THE EARLIEST HE COULD GET IT TO US WOULD BE TUES. MORNING. THERE ARE ONLY ABOUT TEN OR TWELVE PAGES, SO HE'LL FAX IT.

By:

Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, FL 32608

Telephone Conversation

Conversation With: SCOTT SHELTON	Routing: CO
Representing: HOLSTON	Project Number: 95046
Project Name: BOILER STUDY/ACID PLNT. EN. ST.	Date: 8-28-95
Location: HOLSTON	Time:

SOME COMING TO SCOTT TODAY (SENT TO HIM FRIDAY)

JERRY BOUCHICON HAVING TROUBLE LOCATING PUMP CURVES.

I TOLD SCOTT THAT PUMP CURVES PROBABLY ARE NOT AS NECESSARY AS PUMP DRIVE TURBINE STEAM RATE.

SCOTT WILL SEND INFO AS SOON AS IT GETS TO HIM.

By:

Telephone Conversation

AEI
Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, FL 32608

SONEE HALL	
Conversation With	Routing
HDC	95046-10
Representing	Project Number
HOLSTON BOILER STUDY	8-22-95
Project Name	Date
HOLSTON, TENN.	
Location	Time

I INFORMED SONNEE THAT I COULD NOT RECONCILE THE AIR/FUEL RATIO SHOWN ON PROCESS SCREEN, AND WHICH I RECORDED FOR MY CALCULATIONS. I STATED THAT MY CALCULATIONS FOR 50 CFM NAT. GAS WOULD INDICATE AT LEAST 800 CFM THEORETICAL AIR FOR COMBUSTION, WHILE WHAT WE READ WAS 235 CFM. SONEE SAID THAT THOSE OLD BRICK FURNACES HAD A WHOLE LOT OF LEAKAGE THROUGH WALLS & THIS HAS GIVEN THEM ALL KINDS OF PROBLEMS. SONEE WILL LOCATE BURNER DESIGN DATA AND CALL OR SEND TO ME.

By: [signature]

Telephone Conversation

AEI
Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, FL 32608

SCOTT SHELTON
Conversation With
HOLSTON
Representing
HOLSTON BCR STUDY
Project Name

Location

Routing
95046-00
Project Number
8-7-95
Date

Time

LEFT MSG. ON VOICE MAIL THAT I WAS FOLLOWING UP TO SEE WHAT PROGRESS WAS BEING MADE ON ACCUMULATING MATERIAL WE REQUESTED BY FAX.

ASKED HIM TO RETURN MY CALL.

By:

AEI

Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, FL 32608

Telephone Conversation

615-247-9111 x 3791

Conversation With: SCOTT SHELTON SMCHO-EN	Routing: CO
Representing: HOLSTON	Project Number: 95046-00
Project Name: HOLSTON BLR STUDY	Date: 7-31-95
Location:	Time:

ASKED SCOTT IF HE NEW WHAT PROGRESS HAD BEEN MADE ON OUR REQUEST FOR PUMP & TURBINE DATA. SCOTT SAID HE FIGURED THE REQUEST MUST HAVE BEEN MADE TO OPERATIONS PEOPLE DURING AESE VISITS. I TOLD HIM THE REQUEST WAS VIA FAX TO HIM ON 26 JUNE, 1995. SCOTT SAID HE WOULD HAVE TO DIG INTO IT AND SEE WHAT HAPPENED. I TOLD HIM ANYTHING HE COULD DO TO HELP US OUT WOULD BE APPRECIATED BECAUSE WE NEED DATA FOR ANALYSIS.

By: Paul D. [signature]

Telephone Conversation

AEI
Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, FL 32608

MR. DOGNAZZI (MSG. MACH.)	CLO
Conversation With	Routing
HARTFORD	95046-00
Representing	Project Number
HOLSTON BOILER STUDY	7-21-95
Project Name	Date
Location	Time

LEFT MESSAGE THAT VAAP FACILITY IS ESSENTIALLY "CLOSED" OF FRIDAY'S

ASKED FOR RETURN CALL

STATED THAT AESE WILL BE ON BOARD @ VAAP ON TUES. MORN.

By: [signature]

Telephone Conversation

AEI

Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, FL 32608

AL DOGNAZZI	CO, PDL
Conversation With	Routing
HARTFORD STEAM BOILER INSPECTION & INSURANCE CO.	95046-00
Representing	Project Number
HOLSTON AAP BOILER STUDY	7/14/95
Project Name	Date
HOLSTON, TN	1:55 PM
Location	Time

MR. DOGNAZZI INQUIRED AS TO THE STATUS OF THE PURCHASE ORDER OR OTHER ACKNOWLEDGEMENT OF HIS CONTRACT FOR THE BOILER INSPECTION. HE WOULD ACCEPT A VERBAL ACKNOWLEDGEMENT TODAY OR MONDAY TO KEEP THE PROJECT ON THE PRESENT TIMETABLE. I ALSO CONFIRMED EITHER PAUL LITTLE OR CARL OSBERG AS FUTURE CONTACT PERSONS.

By: BOB BARNES
HVAC PROJECT ENGINEER

Telephone Conversation

Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, FL 32608

AL DOGNAZZI (404-928-0788)	CO, PDL
Conversation With	Routing
HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.	95046-00
Representing	Project Number
HOLSTON AAP BOILER STUDY	7/11/95
Project Name	Date
HOLSTON, TN.	9:20 AM
Location	Time

I CALLED MR DOGNAZZI TO CLARIFY HIS ITINERARY (REFER TO FAX DATED JULY 10, 1995 FROM HARTFORD). SPECIFICALLY, I INQUIRED IF OUR PRESENCE WAS REQUIRED MONDAY, JULY 24, 1995. MR DOGNAZZI RESPONDED THAT THE BULK OF THE TESTING AND INSPECTION WOULD BE PERFORMED TUESDAY, WEDNESDAY AND THURSDAY. I INFORMED MR. DOGNAZZI THAT WE WOULD PLAN TO CONDUCT OUR PORTION OF THE FIELD INVESTIGATION DURING THE TUESDAY THROUGH THURSDAY TIME FRAME.

MR DOGNAZZI INFORMED ME HE WOULD LIKE TO CONDUCT A PRE-INSPECTION SURVEY PROBABLY ON JULY 19, 1995, AND ASKED IF WE COULD CONTACT THE APPROPRIATE PERSONNEL AT VOLUNTEER AAP AND ARRANGE A CAMERA PASS. I INFORMED HIM I WOULD DO SO AND CONFIRM THE FACT WITH HIM LATER TODAY.

By: ROBERT A BARNES, P.E.
HVAC PROJECT ENGINEER

Telephone Conversation

Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, FL 32608

AL DOGNAZZI (404-928-0788)	CO
Conversation With	Routing
HARTFORD STEAM BOILER INSPECTION & INSURANCE CO.	95046-00
Representing	Project Number
HOLSTON AAP BOILER STUDY	7/10/95
Project Name	Date
HOLSTON, TN	9:55 AM
Location	Time

I LEFT A VOICEMAIL MESSAGE THAT WE WOULD LIKE TO HAVE TESTING BEGIN ON JULY 24, 1995. I WILL START REQUEST FOR BOILER DATA FROM JIM FRY AT VAAP TODAY.

IMPORTANT MESSAGE

FOR RB

DATE 7-10 TIME 910 A.M. P.M.

M Al Dognazzi

OF Hartford Steam Boiler

PHONE 404 928 0788
AREA CODE NUMBER EXTENSION

☐ FAX

☐ MOBILE
AREA CODE NUMBER TIME TO CALL

TELEPHONED	X	PLEASE CALL	
CAME TO SEE YOU		WILL CALL AGAIN	
WANTS TO SEE YOU		RUSH	
RETURNED YOUR CALL		WILL FAX TO YOU	

MESSAGE Hartford can start on 24 or 31 of July - lv. msg. on voice mail as to when you want.

SIGNED [illegible]

TOPS FORM 4005 LITHO IN U.S.A.

By: ROBERT A. BARNES, P.E.
HVAC PROJECT ENGINEER

Telephone Conversation

AEI

Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, FL 32608

Conversation With: CARL OSBERG

Representing: AESE

Project Name: COE HOLSTON AAP BOILER STUDY

Location: HOLSTON, TN

Routing:

Project Number: 95046-00

Date: 7/7/95

Time: 10:25

GET ITINERARY FROM AL BOGNAZZI SO WE CAN SCHEDULE OUR INSPECTION.

GET INFO FROM JIM FRY ON BOILERS.

INFORM PAUL LITTLE RE: SITE INVESTIGATION TRIP TO VOLUNTEER AND ALSO TRIP TO HOLSTON TO FAMILIARIZE HIM WITH PROJECTS.

By: BOB BARNES

Telephone Conversation

AEI
Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, FL 32608

NED WEIGEL (615-756-4517)	
Conversation With	Routing
WEIGEL ENGINEERING	95046-00
Representing	Project Number
COE HALSTON AAP BOILER STUDY	6/28/95
Project Name	Date
CHATTANOOGA, TN	2:30 PM
Location	Time

CAN CONVERT COAL TO GAS

CONTINUOUS ASH ~~DUMP~~ DISCHARGE STOKER

POLVERIZED COAL NOT PRACTICAL

GAS PRACTICAL

PACKAGED BOILERS PRACTICAL CHOICE

By: ______________________

Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, FL 32608

Telephone Conversation

TOM ROBERTS (404-939-6292)	
Conversation With	Routing
BABCOCK & WILCOX	95046-00
Representing	Project Number
COE HOLSTON AAP BOILER STUDY	6/28/95
Project Name	Date
HOLSTON, TN	
Location	Time

MR. ROBERTS WAS NOT AVAILABLE ON 6/28/95. I WILL CALL AGAIN 6/29/95.

By: BOB BARNES

Telephone Conversation

AEI
Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, FL 32608

JOHN MANNING (617-255-4740)	
Conversation With	Routing
FACTORY MUTUAL ENGINEERING ASSOC.	95046-00
Representing	Project Number
HOLSTON AAP BOILER STUDY	6/15/95
Project Name	Date
HOLSTON, TN	2:20 PM
Location	Time

I LEFT A PHONE MESSAGE ON MR. MANNINGS ANSWERING MACHINE TO CALL ME BACK.

By: BOB BARNES, P.E.
HVAC PROJECT ENGINEER

Telephone Conversation

Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, FL 32608

OUT OF TOWN

JERRY
GARY ANDREWS (817-543-8032)

Conversation With

OLD REPUBLIC INSURANCE CO.

Representing

HOLSTON AAP BOILER STUDY

Project Name

HOLSTON, TN

Location

Routing

95046-00

Project Number

6/5/95

Date

2:28

Time

RICKY BRYAN IS PERSON TO TALK TO. HE WILL RETURN CALL.

By: BOB BARNES
HVAC PROJECT ENGINEER

Telephone Conversation

AEI
Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, FL 32608

WOODELL
EDGAR ~~WHITTLE~~ (617-725-7309)
Conversation With

Routing

COMMERCIAL UNION INSURANCE CO.
Representing

95046-00
Project Number

HOLSTON AAP BOILER STUDY
Project Name

6/5/95
Date

HOLSTON, TN
Location

1:15 PM
Time

OUT FOR THE REST OF THE DAY. I WILL CALL TOMORROW 6/6.

By:

Telephone Conversation

AEI

Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, FL 32608

EDGAR WHITTLE 617-725-7309	
Conversation With	Routing
COMMERCIAL UNION INSURANCE CO.	95046-00
Representing	Project Number
HOLSTON AAP BOILER STUDY	6/2/95
Project Name	Date
HOLSTON, TN	4:30 PM
Location	Time

MR. WHITTLE OUT TILL NEXT WEEK, OFFICE CLOSED
I WILL CALL BACK NEXT WEEK.

By: ROBERT A. BARNES

Telephone Conversation

Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, FL 32608

JOHN MANNING (617-255-4740)	
Conversation With	Routing
FACTORY MUTUAL	95046-00
Representing	Project Number
HOLSTON AAP BOILER STUDY	6/2/95
Project Name	Date
HOLSTON, TN	4:25 PM
Location	Time

CALLED & LEFT MESSAGE ON ANSWERING MACHINE.

By: ROBERT A. BARNES

Telephone Conversation

AEI

Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, FL 32608

STEVE RUDNICKAS (617-255-4270)
Conversation With

FACTORY MUTUAL ENGINEER
Representing

HOLSTON AAP BALER STUDY
Project Name

HOLSTON, TN
Location

95046-00
Project Number

6/2/95
Date

4:15 PM
Time

Routing

MR. RUDNICKAS RECOMMEND CONTACTING
FM RESEARCH LAB NDE
JOHN MANNING, METALLURGICAL LAB
1151 BOSTON PROVIDENCE TURNPIKE
NORWOOD, MA 02062 TEL. 617-255-4740

By: ROBERT A. BARNES

Telephone Conversation

AEI

Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, FL 32608

AL DOGNAZZI
Conversation With

HARTFORD STEAM BOILER
Representing

COE HOLSTON AAP BOILER STUDY
Project Name

KINGSPORT, TN
Location

Routing

95046-00
Project Number

5/26/95
Date

8:30 AM
Time

I ADVISED MR. DOGNAZZI ~~THAT~~ THE TESTING AND INSPECTION OF THE TWO BOILERS AT VOLUNTEER AAP HAS BEEN DELAYED DUE TO CORPS REVIEW OF THE COST OF THE TESTING. WE WILL ADVISE HIM NEXT WEEK HOW THINGS ARE OR AREN'T PROGRESSING AND TRY TO COME UP WITH A NEW SCHEDULE FOR TESTING.

By: BOB BARNES, P.E.
HVAC PROJECT ENGINEER

Telephone Conversation

AEI

Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, FL 32608

(617-255-4272)

Conversation With: FACTORY MUTUAL ENGINEERING ASSOCIATION

Routing: 95046-00

Representing: HOLSTON AAP BOILER STUDY

Project Number: 5/19/95

Project Name: HOLSTON, TN

Date: 2:30 PM

Location

Time

ROOD-NICK-US

STEVE RUDNICKAS, MANAGER 617-255-4270

CALL NEXT WEEK TO SEE ABOUT PROPOSAL REQUEST

By: BOB BARNES

HVAC PROJECT ENGINEER

Telephone Conversation

AEI
Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, FL 32608

GENE HENNESSY (704-362-4499)
Conversation With

ROYAL INSURANCE
Representing

HOLSTON AAP BOILER STUDY
Project Name

HOLSTON, TN
Location

Routing

95046-00
Project Number

5/14/95
Date

4:00 PM
Time

THEY DON'T DO CONTRACT WORK ANYMORE.

By: BOB BARNES
HVAC PROJECT ENGINEER

AEI

Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, FL 32608

Telephone Conversation

HANK PAULSON? (704-522-2932)
Conversation With

ROYAL INSURANCE
Representing

HOLSTON AAP
Project Name

Location

Routing

95046-00
Project Number

5/19/95
Date

3:55 PM
Time

CALL
GENE HENNESSY CHARLOTTE, NC 704-362-4499
362-4453

By:

Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, FL 32608

Telephone Conversation

Conversation With: TOM ROBERTS 404-939-6292	Routing: CO
Representing: BABCOCK & WILCOX CO., ATLANTA, GA	Project Number: 95046-00
Project Name: HOLSTON AAP AREA "A" BOILER STUDY	Date: 5/19/95
Location: HOLSTON, TN	Time: 11:30 AM

I ASKED MR. ROBERTS IF CHANGING THE TESTING DATES FORWARD OR BACK 1 WEEK WOULD ENABLE HIM TO PROVIDE A PROPOSAL FOR THIS PROJECT. MR. ROBERTS INFORMED ME THAT THE REMOTE FIELD EDDY CURRENT TEST APPARATUS THEY OWNED WAS OUT FOR REPAIRS AND WOULD NOT BE AVAILABLE BY THE TIME FRAME REQUESTED IN OUR REQUEST FOR PROPOSAL. ADDITIONALLY, MR. ROBERTS ADVISED ME THAT SUBCONTRACTING OUT THE RFEC TESTING WOULD NOT MAKE HIM COMPETITIVE IN HIS PROPOSAL SO HE DECLINED TO MAKE A PROPOSAL.

I INFORMED MR. ROBERTS THAT I WOULD POSSIBLY BE CONTACTING HIM IN THE FUTURE IF I HAD ANY QUESTIONS ABOUT THE TWO BOILERS AND ANCILLARY EQUIPMENT AT VOLUNTEER AAP IN CHATTANOOGA, TN.

By: ROBERT A. BARNES, P.E.
HVAC PROJECT ENGINEER

Telephone Conversation

AEI
Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, FL 32608

AL DOGNAZZI (404-928-0788)	CO
Conversation With	Routing
HARTFORD STEAM BOILERS INSPECTION & INSURANCE CO.	95046-00
Representing	Project Number
HOLSTON AAP BOILER STUDY	4/11/95
Project Name	Date
KINGSPORT, TN	9:15 AM
Location	Time

TONY BATTAGLIA, MOBILE CORPS OF ENGINEERS
ULTRASONIC THICKNESS TESTING
VISUAL INSPECTION
MAG-PARTICLE TESTING
EDDY CURRENT TESTING OF TUBES

REQUESTED RECOMMENDED TESTS & COSTS FOR BOILER INSPECTION.
AL WILL CALL TONY RE: POSSIBLE PRE-INSPECTION TO EVALUATE
PROPOSAL. WILL CALL & ADVISE.

AL DOGNAZZI CALLED BACK AT 11:00 AM 4/11 TO ADVISE HE HAD
CONTACTED TONY BATTAGLIA AND JIM FRY AT VOLUNTEER AAP,
AND HAD TENTATIVE INSPECTION SCHEDULED FOR MON. 4/17/95.

By: ROBERT A. BARNES
HVAC PROJECT ENGINEER

Appendix 6 - Entry/Exit Interviews

Affiliated Engineers SE, Inc.

3300 SW Archer Road
Gainesville, Florida 32608
(904) 376-5500 • FAX (904) 375-3479

MEETING NOTES

HOLSTON AAP CONTRACT NO.: DACA01-94-D-0007	95046-00
Project	Project #
Holston, TN	August 22, 1995
City, State	Date
Exit Interview	1 of 1 DA
Type of Meeting	Page Typist
08/18/95	
Meeting Date	Copies

Present	Representing
Orville Depew	HDC
Sonee Hall	HDC
Carl Osberg	AESE
Paul Little	AESE

The purpose of this meeting was to review the items surveyed and discuss probable areas of energy conservation. The following items were discussed.

Observations were made at the Acetic Anhydride manufacturing equipment in building 7. Natural gas and combustion air quantities at one cracking furnace, which was in operation, were obtained: 50 CFM main burner N.G., 5 CFM Pilot N.G., and 235 CFM Air. It was noted that flue gas temperature exiting the furnace is 329°C. The waste heat boilers manufactured by Union Iron Works, were originally selected for conditions existing with producer gas used as fuel. The units are single pass firetube type. It was noted that discussions have previously taken place to address feasibility of incorporating auxiliary burners on these units, but detailed investigation was never completed. A boiler cross sectional drawing was obtained indicating the quantity and size of boiler tubes. Nominal tube length was measured as 15 feet.

At steam plant building 8, Mr. Hall stated that all tar handling equipment and concrete dike/basin will be removed prior to work related to installation of boilers from VAAP, if in fact, those boilers are to be used. Mr. Davenport pointed out the burner port for burning tar, which might make installation of a natural gas burner possible. It was also pointed out that only three sides of the boiler fire box section contain water wall tubes; The wall opposite the tar burner does not contain riser tubes.

Mr. Davenport stated that the river water piping "loop" has now been completed, so that the electric driven pump previously called the "backside" pump is available for any high head system pumping requirements. Mr. Hall indicated that current operations are being met without utilizing turbine driven river water pumps, and this configuration is maintained under conditions requiring less than about 100,000 #/hr boiler plant load.

Mr. Davenport was asked how often the coal bunkers are filled. He stated each bunker capacity is 200 ton, and at present they burn about 70 tons each day.

The above constitutes the writer's understanding of the discussions of this meeting and conclusions reached. Corrections/errors should be noted to the writer within 5 working days.

By,

Paul D. Little

Paul Little, P.E.

HVAC Project Engineer

Affiliated Engineers SE, Inc.

3300 SW Archer Road
Gainesville, Florida 32608
(904) 376-5500 • FAX (904) 375-3479

MEETING NOTES

HOLSTON AAP CONTRACT NO.: DACA01-94-D-0007	95046-00
Project	Project #
Holston, TN	June 2, 1995
City, State	Date
Exit Interview	1 of 2 MAH
Type of Meeting	Page Typist
05/25/95	CO, MR
Meeting Date	Copies

Present	Representing
Jerry Bouchillon	HDC
J.L. "Butch" Jones	HDC
Sonee Hall	HDC
George Davenport	HDC
Max G. Noe	HDC
D.L. Cretsinger	HDC
Richard Gillenwater	HDC
Van Jones	HDC
Mike Richarme	AESE
Bob Barnes	AESE

The purpose of this meeting was to review the items surveyed and discuss probable areas of energy conservation. The following items were discussed.

1. Bob Barnes briefly reviewed the scope of work for this project and described some of the options available for saving energy for this project. Among the options were the relocation and reuse of one or two existing gas fired boilers at Volunteer Army Ammunition Plant (VAAP) in Chattanooga, TN. Other options included new boilers either at the existing boiler plant or located near the points of use. Re-use of existing feedwater equipment appeared feasible but would be analyzed in detail in the study of this project. Ancillary equipment at VAAP may also be reused but inspection of the equipment would determine the economic feasibility.

2. The question was raised about how the new boilers would affect the current air permit and environmental concerns. A brief discussion of possible scenarios of equipment, fuels, and siting followed. More definite information would be developed by AESE during the course of the study which would be forwarded to HDC to be evaluated for impact on this project.

3. An additional question was raised regarding the interruptability of natural gas supplies and back-up fuels or storage to protect process equipment and product. Jerry Bouchillon will check on the interruptability of natural gas, as the current contract with United Cities Gas Company is for uninterruptable natural gas supply. Fuel oil is not desired by HDC due to storage and environmental concerns. Other possible alternatives might be electrical back-up for critical needs (such as pumps, heating tracing, bayonet heaters, etc.) but duration of interruption needs to be determined as well as identifying systems and components requiring backup.

4. As part of the study, Jerry Bouchillon recommended overhead costs be included in operation and maintenance costs. Jerry had previously furnished data on "out-of-pocket costs" for steam to be used as part of the economic analysis for this project.

5. Mike Richarme suggested there could possibly be some cost savings on electricity costs due to power factor billing by the utility company. However, this proved not to be the case as HDC owns and maintains the electrical distribution equipment downstream of the primary metering location and has done a good job correcting power factor conditions and line losses.

The above constitutes the writer's understanding of the discussions of this meeting and conclusions reached. Corrections/errors should be noted to the writer within 5 working days.

By:

AFFILIATED ENGINEERS SE, INC.

Robert A Barnes

Robert A. Barnes, P.E.
HVAC Project Engineer

Affiliated Engineers SE, Inc.

3300 SW Archer Road
Gainesville, Florida 32608
(904) 376-5500 • FAX (904) 375-3479

MEETING NOTES

HOLSTON AAP CONTRACT NO.: DACA01-94-D-0007	95046-00
Project	Project #
Holston, TN	June 2, 1995
City, State	Date
Entry Interview	1 of 2 MAH
Type of Meeting	Page Typist
05/22/95	RB, MR
Meeting Date	Copies

Present	Representing
Scott Shelton	SMCHO-EN
Sonee Hall	HDC
George Davenport	HDC
Max G. Noe	HDC
Carl Osberg	AESE
Mike Richarme	AESE
Bob Barnes	AESE

The purpose of this meeting was to have an entry interview and the following items were discussed.

1. Production levels of explosives was 14 million pounds (lbs) in 1994, 7 million lbs projected in 1995, and about 2 million lbs projected for 1996. Production levels beyond 1996 are not available at this time.

2. Current plans are to replace steam turbine drives at refrigeration machines in Building 5 to electrical motors.

3. Holston Defense Corporation (HDC) is presently investigating the possibility of buying or selling steam from Tennessee Eastman.

4. There are no steam lines between Area "A" and Area "B".

5. Electric power is supplied to HDC from Kingsport Power at a single substation with a back-up from Appalachian Power (TVA).

6. Shelby Jones is presently investigating alternative electric power sources.

7. In Building 8, Boiler 7 is currently laid away, and plans are to lay away Boilers 3, 5, and 6. Boilers 1 and 2 are used alternately with Boiler 4 inactive but capable of being fired. HDC has an estimate of the cost of boiler lay-up which will be furnished later.

8. Process steam requirement is 90 psig and most is used in Building 2.

9. Cogeneration is under investigation by HDC as a possible solution to supplying steam for Area "A" but this has been excluded from the AESE Limited Energy Study.

10. PCB containing transformers are routinely removed from Holston AAP which has a holding area for temporary storage of transformers prior to their disposal.

The above constitutes the writer's understanding of the discussions of this meeting and conclusions reached. Corrections/errors should be noted to the writer within 5 working days.

By:

AFFILIATED ENGINEERS SE, INC.

Carl L. Osberg

Carl L. Osberg, P.E.
Vice President

Appendix 7 - Response to Comments

MOBILE DISTRICT PROJECT REVIEW COMMENTS	DATE: 28 Sept. 1995	Page 291 of 5
TO: U.S. Army Corps of Engineers Mobile District Mobile, AL	FROM: Robert S. Woodruff, CESAM-EN-DM PHONE: (334) 694-6074 FAX: (334) 690-2424	
PROJECT/FY: FY95 Limited Energy Study for Area "A" Package Boilers		
LOCATION: Holston Army Ammunition Plant, Kingsport, TN		
TYPE REVIEW: Interim Submittal Review		

NO.	PAGE/PAR	COMMENT	RESPONSES TO COMMENT
1.	Exec. Sum. P.2	What is Synergism Analysis?	*Interaction of discrete elements of system changes, the combination of which may produce more or less desirable effects than the sum of the individual changes alone. A/E will so state in the report.*
2.	Part II P. 6	The fact that the chillers are being converted to electric drive as well as the fact that the existing distribution system is to be reused are "givens" and do not require evaluation.	*None.*
3.	Part II P. 6	The items outlined on this page are not the same as those stated in the detailed scope of work. These should be identical.	*A/E will clarify which of these items were addressed at Entry/Exit Interviews.*
4.	Part II P. 8	Item 4) gives the electrical consumption of the steam plant equipment. Does this value come from the actual operating logs?	*Assumption based on 1994 Tony Battaglia steam cost calcs.*
5.	Part II P. 25	The first paragraph on this page states that no differentiation was made between energy and demand charge for electric service. Because demand charges are really paid for the entire 12 months wouldn't this have an effect on the economics?	*Effect is insignificant. Report will be modified explain.*
6.	General	Would it be prudent to consider a 30,000 #/HR gas fired boiler not using the existing stacks? That way enough steam would be produced to meet the small demands without having to vent any steam.	*Yes.*

MOBILE DISTRICT PROJECT REVIEW COMMENTS	DATE: 28 Sept. 1995	Page 2 of 5
TO: Affiliated Engineers SE, Inc. Gainesville, FL	FROM: Anthony W. Battaglia, CESAM-EN-DM PHONE: (334) 694-2618 FAX: (334) 690-2424	
PROJECT/FY: FY95 Limited Energy Study for Area "A" Package Boilers		
LOCATION: Holston Army Ammunition Plant, Tennessee		
TYPE REVIEW: Interim Submittal Review		

NO.	PAGE/PAR	COMMENT	RESPONSES TO COMMENT
1.	General	The conclusions reached by this report appear to be reasonable, and some aspects of the report are quite good; however, in some respects it is incomplete, and there are several areas which need clarification.	*None.*
2.	General	Not all of the topics listed in the Detailed Scope of Work have been adequately addressed. The following comments are keyed to the topics listed in the Detailed Scope of Work, paragraph 4., pages A-2 & A-3:	
		Sub-par 4.a., Evaluation of Gas-fired Package Boilers: For the case of the boilers relocated from Volunteer AAP, this has been adequately addressed; but it has not addressed boilers sized to meet the current requirements. This should be added to the evaluation.	*A/E will incorporate.*
		Sub-par 4.b., Use of Existing Distribution System: Adequately addressed.	*None.*
		Sub-par 4. c., Existing steam-driven chillers replaced with electric: The steam requirement for the chillers must be subtracted from the overall steam requirement; cannot determine how this was accommodated in the calculations. Please clarify.	*A/E will clarify.*
		Sub-par 4.d., Inspection of existing boilers at Volunteer AAP: Adequately addressed.	*None.*
		Sub-par 4.e., Evaluation of existing ancillary equipment at Volunteer AAP: No clear statement was made regarding this equipment, nor how it would affect the cost/savings. Please include.	*A/E will clarify.*
		Sub-par 4.f., Maintenance and Operation Costs: Either this was not adequately addressed or there is some discussion missing. Please include or elaborate.	*A/E will elaborate.*
		Sub-par 4.g., Fuel oil storage capacity: No analysis has been provided, please include.	*A/E will include.*
		Sub-par 4.h., Air pollution permits: No discussion was included regarding impacts of the proposed changes. Please indicate.	*A/E will add statement that no impact is involved.*
		Sub-par 4.i., River water Pumps: There appears to have been a misunderstanding regarding this topic. The scope of work says that the pumps are currently (at the time of the pre-negotiation conference) electrically driven, although each has a steam turbine connected to the same shaft. The study is supposed to evaluate the economics of using the turbines instead of the motors. If there was a change in the method of operation prior to starting the field work, this should have been stated in the report. Please revise as needed.	*A/E will clarify.*
3.	General	The AE is commended for proposing additional ECOs as possible solutions to the problem.	*None.*
4.	Detailed Narrative General	In the detailed narrative there is some discussion of each case (1 thru 5) investigated; however, it is not detailed enough to really give the reader an understanding of the costs/savings involved. Please expand.	*A/E will comply.*

5.	Energy Calcs, General	In the detailed narrative, there is a discussion of the spreadsheet calculations used for determining energy consumption; however, there are no sample calculations to show how the spreadsheet numbers were generated. Please include.	*A/E will comply.*
6.	LCCAs, General	The LCCA summary Sheets should not be under "Miscellaneous Data". Each sheet should be included with the discussion of the pertinent ECO.	*A/E will comply.*
7.	Pg 2 & 3	Case 1 & Case 2: These cases appear to be reversed with respect to the river water pumps. See Comment 2, sub-par 4.i., above.	*A/E will comply.*
8.	Pg 4	The penultimate sentence states that the savings are negative, but makes no attempt to explain the situation. Please clarify.	*A/E will amplify.*
9.	Pg 6	3rd bullet: Notes replacement of steam driven chillers with electric. Be sure this is included in the base case; see Comment 2, sub-par 4.c., above.	*A/E will comply.*
10.	Pg 8	Par 5): Reference records (in Appendix, I presume) that were used in determining these costs.	*A/E will comply.*
11.	Pg 8	Par 9): Have you checked with turbine manufacturers to see if turbines can be operated with saturated steam?	*Mollier Charts.*
12.	Pg 11	States, "Production levels below 167,000 lb/month have not been evaluated." The graphs provided do not even go as low as 167,000 lb/month. Perhaps they should. Please check and correct as necessary.	*Expanded graphs available.*
13.	Pg 17	Case 1: See Comment 2, sub-par 4.i.	*None.*
14.	Pg. 18-22	Figures 8 - 12: The axis for "ANNUAL COST" does not identify "cost of what". The axis for "Lbs/Month" appears should be "Millions of Lb/Month". Please correct.	*A/E will correct.*
15.	Pg 23 & 24	Table 1 & Table 2 would be easier to follow if they were combined into a foldout or if each case were on a separate table printed horizontally. Please consider.	*Reformatted tables available.*
16.	Pg 25	First paragraph: States that no attempt was made to differentiate between energy cost and demand cost, but gives no justification for this approach. Usually it is worth while to consider the effects of both. Please discuss.	*A/E will include additional evaluation.*
17.	Pg 96	LCCA for Case 2: This may change based on Comment 2, but why would there be no coal cost or savings if a change was made from electricity to steam (or vice-versa) for driving the pumps? Please correct as necessary.	*Minimum boiler oper. point - steam blown to atmosphere.*
18.	Pg 97, 98, & 99	LCCA for Case 3, Case 4, & Case 5: I don't understand the asterisks under "Savings" for natural gas. I would expect there to be a negative number in this location. Please explain.	*LCCID format not adjustable calculated value is out of range for this summary sheet.*
19.	General	The combustion calculations look very good.	*None.*
20.	Pg 133	Cost Estimate: Please provide some backup for the lump sum costs for Bailey Motor Co. Control Rehab and for Misc piping, tubing, valves & fittings.	*Backup will be provided.*
21.	Pg. 134	Please provide some backup for Transporting and for Boiler Startup.	Unintentional omission.
22.	Pg. 136	This is hard to follow. Please include more explanation of details, and improve format.	*A/E will comply.*
23.	General	In the appendices there are several invoices and other documents which have been highlighted. The highlighted figures become opaque when reproduced; so the copies become essentially useless. Please find a better way to present this information.	*A/E will annotate documents.*

24.	Pg 139	Demand charge for natural gas. Will this change with increased use? Please discuss.	*Discussion will be provided.*
25.	Pg 168	Table: Please indicate units in the column headings (lb/hr)?	*A/E will comply.*
26.	Pg 170	Label fan & motor.	*A/E will comply.*
27.	Pg 172	Indicate proposed size of steam lines leaving new boilers.	*A/E will comply.*
28.	Noted	The following are nit-picky editorial comments:	
	Pg 1	Holston AAP is in Kingsport, TN.	*A/E will correct.*
	Pg 2	No. 11: "Benefit/Cost" ratios.	*A/E will comply.*
	Pg 2	Correct spelling of "alternative".	*A/E will comply.*
	Pg 11	3413 Btu/kWh	*A/E will comply.*
	Pg 11	"...calculations are presented..."	*A/E will comply.*
	Pg 25	Correct spelling of "differentiate".	*A/E will comply.*

MOBILE DISTRICT PROJECT REVIEW COMMENTS	DATE: 28 Sept. 1995	Page 295 of 5
TO: U.S. Army Corps of Engineers Mobile District Mobile, AL	FROM: Jerry Bouchillon (HDC Engineering) Sonee Hall (HDC Utilities)	
PROJECT/FY: FY95 Limited Energy Study for Area "A" Package Boilers		
LOCATION: Holston Army Ammunition Plant, Kingsport, TN		
TYPE REVIEW: Interim Submittal Review		

NO.	PAGE/PAR	COMMENT	RESPONSES TO COMMENT
1.	General	This study appears to be a respectable analysis of the subject manner.	
2.	Pg 4	The FINDINGS, ANALYSIS AND RESULTS are not very definitive. What is the meaning of a negative SIR? Why can't the short, candid CONCLUSION of page 25 be put on page 4?	*A/E will consider revisions as requested.*
3.	General	I would like to see a step-wise sample calculation showing how each of the 12 parts for a given condition (example: Case 3, 0.075 mill #/mo) on Tables 1 and 2 are obtained.	*A/E will provide.*
4.	General	Please be consistent with units on all tables, text and figures. For example, say, "750,000 #/MO Eq RDX" instead of "0.75 MILL #/MO", etc.	*A/E will edit as required.*
5.	General	Any analysis involving LCCID of Cases 4 and 5 (using VAAP Boilers) shall include consideration for the cost to layaway Building 8A since this will be a natural consequence of making this change.	*Feedwater system, boiler water treatment and deaerator continue in service coal boilers can be laid away.*
6.	General	All "units costs" in units of $/MBtu for the LCCID's (pages 96-99) shall be changed to reflect the unit costs of STEAM generated with these fuels similar to the analysis on page 145 for coal instead of the unit cost of the heating value of the fuels. For example, coal = 3.00 $/MBtu instead of 1.86 $/MBtu.	*LCCID instructions call for fuel costs and non-energy savings account for remainder.*
7.	Pg 96-99	In the LCCID's changes the SIOH and Design Costs to reflect more realistic values. These can be obtained from Tony Battaglia unless you have already done so.	*A/E will revise if directed to do so; values shown are program default values.*

Appendix 8
Indeck Power Equipment Company
Lease Proposal

INDECK POWER EQUIPMENT COMPANY • 1111 SOUTH WILLIS AVENUE • WHEELING, ILLINOIS 60090-5841
708/541-8300 • TELEX 28-3544 • FAX 708/541-8984

INDECK

October 25, 1995

Affiliated Engineers S. E., Inc.

Attn: Mr. Paul Little

FAX #: 1-904-375-3479

REFERENCE: YOUR TELEPHONE INQUIRY OF OCTOBER 24, 1995
INDECK PROPOSAL #6421

SUBJECT: 800 HP BOILER AND DEAERATOR RENTAL PROPOSAL

Dear Mr. Little:

Per the above referenced telephone conversation in which we discussed the possible rental of an 800 HP firetube boiler and a duplex packaged deaerating system for a U.S. Government operation in Tennessee, I am pleased to provide the following information for your review, evaluation and further rental consideration.

INDECK POWER EQUIPMENT COMPANY PROPOSES TO FURNISH:

One (1) New 800 HP Donlee Technologies (York-Shipley) 3-pass packaged automatic firetube boiler, Model #596-SPH-800-N/2. This unit will be designed, built and stamped in accordance with the latest edition of the ASME Power Boiler Code, Section I for a design pressure of 150 psig and an operating pressure range of 50-125 psig. The unit will be equipped with a York-Shipley designed and built natural gas and #2 oil fired forced draft, fully modulating burner. The unit will be complete with the manufacturer's standard boiler trim, burner and controls as per the following specification sheets as well as the following recommended optional equipment:

a. Stack thermometer - installed
b. 2" blowdown valves - two quick and one slow opening (shipped loose)
c. Warrick probe type auxiliary low water cut off, Model #3E1B
d. 2" Jordan electric modulating feedwater valve with 3-valve bypass
e. 460 V, 3-phase, 60 Hz main power with a 120 V, single phase control voltage transformer
f. Single electric location connection with circuit breakers
g. Three (3) indicating lights (customer to specify function)
h. Manual reset steam limit control
i. Manual potentiometer for manual firing rate adjustment

INDECK®

Page 2.

One (1) packaged duplex feedwater deaerating system consisting of a 30,000 PPH horizontal storage tank designed, built and stamped to the ASME Code for 50 psig design pressure and will have 10 minute storage to overflow. The vessel will be complete with make-up water regulating valve with float cage and operating linkage, overflow trap, steam pressure reducing valve, high and low water level switches, sentinel type relief valve, vent valve, water level gauge glass set, steam pressure gauges and two (2) thermometers. The vessel will be mounted on a 4-post structural steel support stand with pads to match the deaerator tank saddles, foundation pads with holes, base plate for pump sets with structural steel horizontal and diagonal support braces. Mounted beneath the vessel will be two (2) centrifugal boiler feedwater pumps, each with a minimum flow rate of 60 gpm at 150 psig pump discharge pressure coupled to drip-proof drive motors requiring 460 V, 3-phase, 60 Hz power. A control panel in a NEMA 1 enclosure will be furnished and include two (2) pump motor starters, pump circuit breakers, pump running lights, high and low water lights with alarm bell and silencing switch, pump selector switch and terminal switch. Duplex suction piping assembly which includes gate valves, flexible connectors, compound gauges and pipe supports. Discharge piping will be supplied with a separate gate and check valve and pressure gauge. The unit will be shop assembled with the horizontal storage tank and some trim removed to facilitate shipping clearances.

Based on a minimum guaranteed rental term of 36 months, a budgetary monthly rental rate for the boiler and deaerator as described above is $3,800.00.

Delivery of this equipment is approximately 12-14 weeks after receipt of approved contract.

The following two pages are the boiler and burner specifications and should you require additional information on either the boiler or deaerator please feel free to contact me at your convenience.

Thank you for your inquiry and I look forward to working with you further when you have final specifications available for firm pricing.

Very truly yours,

INDECK POWER EQUIPMENT COMPANY

Wayne J. Cerny

Wayne J. Cerny
Vice President
Sales and Rentals

SAMPLE SPECIFICATIONS

HIGH PRESSURE STEAM BOILERS
(150 PSI OR HIGHER)

A. GENERAL

FURNISH (~~AND INSTALL~~) ONE PACKAGED SCOTCH TYPE STEEL BOILER(~~S~~) DESIGNED AND CONSTRUCTED FOR (150) (150) PSIG STEAM PRESSURE IN ACCORDANCE WITH SECTION I ASME CODE. THE UNIT SHALL BE MOUNTED ON A STEEL FRAME, COMPLETE WITH BURNER AND ALL NECESSARY CONTROLS, AND SHALL BE FACTORY ASSEMBLED AND FIRE TESTED, READY FOR ATTACHMENT OF STEAM SUPPLY AND FEEDWATER LINES, BLOW-OFF PIPING, FUEL LINES, ELECTRICAL CONNECTIONS, AND VENT/BREECHING CONNECTION. THE ENTIRE UNIT SHALL BEAR THE UNDERWRITER'S LABORATORY B LABEL.

THE BOILER SHALL HAVE A CONTINUOUS NOZZLE RATING OF 800 BOILER HORSEPOWER, 27,600 LBS. OF STEAM/HR., AND 26800 MBH GROSS OUTPUT, AND SHALL BE A YORK-SHIPLEY MODEL 596-SPH-800-N/2.

B. BOILER DESIGN

THE BOILER SHALL BE OF THE FIRE TUBE TYPE, THREE PASS, DRY-BACK DESIGN. THE BOILER SHALL HAVE (A MINIMUM OF FIVE SQUARE FEET PER BOILER HORSEPOWER OR A TOTAL OF) 4000 SQUARE FEET OF EFFECTIVE FIRESIDE HEATING SURFACE. IT SHALL BE PROVIDED WITH HANDHOLES AND A MANHOLE AS REQUIRED BY ASME CODE.

THE BOILER SHALL BE COVERED ON SIDES AND TOP WITH A MINIMUM OF 2" OF GLASS WOOL INSULATION AND PROTECTED BY A 22 GAUGE SHEET STEEL JACKET. A HEAVY GAUGE STEEL CATWALK SHALL BE INCLUDED AS PART OF THE JACKET ALONG THE TOP LONGITUDINAL CENTERLINE OF THE BOILER SHELL.

THE FURNACE TUBE SHALL BE CENTRALLY LOCATED IN THE BOILER SHELL, AND SHALL BE EQUIPPED WITH A REFRACTORY TARGET RING FOR RESHAPING THE FLAME AT A POINT WHERE IT BEGINS TO SPREAD. ALL REFRACTORY BRICKWORK SHALL BE HIGH TEMPERATURE FIREBRICK AND/OR PRE-CAST REFRACTORY SHAPES LAID IN HIGH TEMPERATURE REFRACTORY CEMENT. THE REAR TURNING CHAMBER SHALL BE LINED WITH HIGH TEMPERATURE PRE-CAST REFRACTORY AND BACKED WITH SEAL WELDED STEEL LINING TO PREVENT FLUE GAS SHORT-CIRCUITING.

THE REAR DOOR SHALL BE DESIGNED IN THREE SECTIONS FOR EASE OF REMOVAL AND TO ALLOW ACCESS TO ANY SECTION OF THE FIRESIDE SURFACE WITHOUT REMOVING THE ENTIRE DOOR. THE LOWER REAR SECTION SHALL BE INSULATED OR REFRACTORY LINED AS REQUIRED. THE REFRACTORY LINED SECTION SHALL BE SUPPORTED BY A HINGED DAVIT ARRANGEMENT. THE FRONT DOOR SHALL BE ONE PIECE OR TWO PIECE, AS REQUIRED BY WEIGHT AND SIZE, AND INSULATED WHERE NECESSARY. THE FRONT DOOR SHALL INCLUDE AN ACCESS OPENING FOR CLEANOUT WITHOUT REQUIRING OPENING OF THE DOOR.

C. TRIM AND CONTROLS

THE BOILER SHALL BE EQUIPPED WITH A COMBINATION WATER COLUMN, PUMP CONTROLLER, AND LOW WATER CUT-OFF WITH ALARM SWITCH; AND WITH WATER GAUGE SET AND GLASS, TRY COCKS, AND WATER COLUMN BLOWDOWN VALVE. IN ADDITION, THE BOILER SHALL BE EQUIPPED WITH A SAFETY LIMIT CONTROL AND A SEPARATE OPERATING LIMIT CONTROL. SAFETY VALVES AND A STEAM PRESSURE GAUGE SHALL BE FURNISHED. ALL THE ABOVE EQUIPMENT SHALL BE FACTORY PIPED AND WIRED IN ACCORDANCE WITH ASME CODE AND U/L REQUIREMENTS.

SAMPLE SPECIFICATIONS GAS/#2 OIL BURNERS

FA BURNERS - 400 THRU 1000 HP FOR STEAM-PAK BOILERS

THE BURNER SHALL BE A YORK-SHIPLEY MODEL FA AND SHALL BE DESIGNED FOR FIRING NATURAL GAS OR #2 FUEL OIL, WITH GAS CHARACTERISTICS OF 1000 BTU/CU. FT., SPECIFIC GRAVITY OF ——, AN AVAILABLE GAS SUPPLY ~~PRESSURE OF~~ 2 ("WC) (PSIG), ~~AND A~~ FIRING RATE OF 33,500 CU. FT./HR. GAS AND 235 GPH OIL. THE OVERALL EFFICIENCY OF ~~THE UNIT,~~ BASED ON FUEL INPUT AND ~~BOILER~~ OUTPUT, SHALL BE NOT LESS THAN 80%.

THE BURNER SHALL BE EXTERNAL MIX GAS AND LOW PRESSURE AIR ATOMIZED OIL TYPE, USING A GAS PORT AND OIL NOZZLE ARRANGEMENT WITH AN AIR SWIRL FOR MAXIMUM COMBUSTION EFFICIENCY. IGNITION SHALL BE ACCOMPLISHED BY A SPARK IGNITED NATURAL GAS PILOT USING A 10,000 VOLT IGNITION TRANSFORMER.

THE PILOT SHALL INCLUDE, IN ADDITION TO THE NOZZLE AND ELECTRODE ASSEMBLY, A SOLENOID GAS VAVLE, GAS PRESSURE REGULATOR WITH 5 PSI MAXIMUM INLET PRESSURE RATING, AND A SHUT-OFF COCK.

THE BURNER SHALL BE ARRANGED FOR FULLY MODULATED FIRING, USING A SINGLE MODULATING MOTOR WITH BUILT IN END SWITCH FOR GUARANTEED LOW FIRE START, A LINKAGE ARRANGEMENT TO GOVERN BOTH AIR SUPPLY AND FUEL SUPPLY.

THE BURNER SHALL INCLUDE A HINGED DOUBLE DOOR FULLY ENCLOSED CONTROL PANEL WITH LATCH, MOUNTED SEPARATELY ON THE BOILER, WITH TERMINAL STRIPS FOR MAIN ELECTRICAL POWER CONNECTION AND FOR ALL WIRING RUNNING OUT OF THE PANEL, A CONTROL CIRCUIT FUSE, AN ON-OFF TOGGLE SWITCH, FUEL CHANGEOVER SWITCH, A YS-7000L MICROCOMPUTER TYPE FLAME CONTROL WITH LEAD SULFIDE SCANNER, ALL MOTOR STARTERS (WHERE SPACE PERMITS), RELAYS, TRANSFORMERS, ETC.

THE BURNER SHALL BE FORCED DRAFT TYPE WITH A BLOWER WHICH FURNISHES ALL NECESSARY AIR FOR COMBUSTION, AND INCLUDES AN AIR INLET SILENCER. THE BLOWER AIR SUPPLY SHALL BE GOVERNED BY THE MODULATING MOTOR LINKAGE CONNECTED TO A DAMPER ON THE BLOWER DISCHARGE. THE BURNER SHALL INCLUDE AN AIR SAFETY INTERLOCK FOR LOW BLOWER AIR. THE BLOWER SHALL BE AN AIR FOIL TYPE AND SHALL BE DIRECTLY DRIVEN BY A 40 HP 3500 RPM MOTOR.

THE BURNER WINDBOX SHALL BE FURNISHED WITH A BOLTED-ON ACCESS PLATE FOR EASY REMOVAL OF THE NOZZLE AND ELECTRODE ASSEMBLY. IN ADDITION, THE ENTIRE BACK PLATE OF THE WINDBOX SHALL BE REMOVABLE FOR EASY ACCESS TO THE OTHER INTERNAL BURNER COMPONENTS.

THE BURNER SHALL INCLUDE A SINGLE OIL NOZZLE WHICH PROVIDES FOR MIXING OF FUEL WITH COMPRESSOR AIR INSIDE THE NOZZLE. OIL FLOW SHALL BE CONTROLLED BY A SINGLE SOLENOID VALVE ON THE NOZZLE SUPPLY LINE, PLUS AN ADJUSTABLE TEARDROP TYPE COMBINATION HIGH FIRE AND METERING VALVE, ACTUATED BY THE MODULATING MOTOR LINKAGE. THE OIL SUPPLY LINE TO THE BURNER SHALL INCLUDE A FILTER UPSTREAM OF THE CONTROL VALVES AND SOLENOID VALVE.

OIL PRESSURE AND FLOW SHALL BE PROVIDED BY A FUEL OIL PUMP ARRANGEMENT, MOUNTED ON THE RIGHT REAR BOILER SKID, AND INCLUDING A GEAR TYPE SINGLE STAGE OIL PUMP, BELT DRIVEN BY A 1 HP 1750 RPM MOTOR, ALONG WITH AN OIL PRESSURE GAUGE AND SEPARATE ~~RELIEF VALVE~~; ALL PIPED, MOUNTED, AND WIRED TO THE UNIT. A SIMPLEX SUCTION LINE STRAINER SHALL BE INCLUDED, BUT SHIPPED LOOSE FOR FIELD INSTALLATION.

SAMPLE SPECIFICATIONS CONT'D

GAS/#2 OIL BURNERS

BURNERS - 400 THRU 1000 HP CONT'D

FOR STEAM-PAK BOILERS

COMPRESSED AIR FOR THE AIR ATOMIZATION SHALL BE PROVIDED BY A ROTARY VANE TYPE AIR COMPRESSOR, COMPLETE WITH AIR FILTER, RELIEF VALVE, PRESSURE GAUGE, AUTOMATIC GRAVITY FEED LUBRICATOR, OIL ACCUMULATOR, AND BELT DRIVEN WITH AN ADJUSTABLE SHEAVE ARRANGEMENT AND A 1 HP 1750 RPM MOTOR.

GAS CONTROLS INCLUDE A BUTTERFLY TYPE GAS VOLUME VALVE CONNECTED BY LINKAGE TO THE MODULATING MOTOR, A DOWNSTREAM BLOCK/TEST LUBRICATED PLUG COCK, A MOTORIZED TYPE SAFETY GAS VALVE WITH INTEGRAL PROOF-OF-CLOSURE SWITCH, A PRIMARY MOTORIZED GAS VALVE, AN UPSTREAM SHUT-OFF LUBRICATED PLUG COCK, HIGH AND LOW GAS PRESSURE INTERLOCKS, AND TEST CONNECTIONS DOWNSTREAM OF EACH MOTORIZED VALVE. A NORMALLY OPEN FULL PORTED SOLENOID VENT VALVE SHALL BE INCLUDED BETWEEN THE MOTORIZED GAS VALVES. A MAIN GAS PRESSURE REGULATOR SHALL BE ~~(INCLUDED AND SHIPPED LOOSE)~~ ~~(INSTALLED DOWN-STREAM OF THE MAIN SHUT OFF COCK)~~ (FURNISHED BY OTHERS).

ALL MOTORS SHALL BE ARRANGED FOR CONNECTION TO ~~230~~ 460 VOLTS, 3 PHASE, 60 HERTZ ELECTRICAL POWER AND THE CONTROL SYSTEM SHALL BE ARRANGED FOR 115 VOLTS, 1 PHASE, 60 HERTZ POWER (USING A CONTROL VOLTAGE TRANSFORMER).

CENTRAL TX COMMERCIAL A/C & HEATING, INC.

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Austin, Texas 78736-8018
License #: TACLA 002692C

512/288-0822
1-800-338-5429
Fax #288-0941

October 30, 1995

Affiliated Engineers
Attn: Mr. Paul Little
3300 Southwest Archer Road
Gannsville, FL 32608
Fax (904) 375-3479

Central Texas Commercial Air Conditioning and Heating, Inc. is pleased to propose:

1) Lease for 800 horse power boiler at 100 PSI, including dearator and feed water pumps. Quote includes the following:

   * One 800 Hp or two (2) 400 Hp boilers set up to burn natural gas or #2 fuel oil.
   * Motor for 230/460 volts.
   * 110 volt control transformer.
   * Freight to and from job site.
   * Dearator with dual pumps and controls.
   * Start up after complete installation.

2) Installation is not included.
3) Licensing and insurance are not included.
4) Taxes are not included.
5) Terms and Conditions attached.

First 12 month lease	$7,800.00/month
2nd year lease cost	$5,800.00/month
3rd year lease cost	$4,900.00/month

If you have any questions please don't hesitate to call.

Best Regards,

Roland R. Hampton Jr.

Roland R. Hampton, Jr.
President

RRH:jm